Bulletin of the Minnesota Academy of Natural Sciences

Minnesota Academy of Natural Sciences

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OF THE

MINNESOTA ACADEMY OF SCIENCE

VOL. IV

1892 ---- 1910

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1910

CONTENTS

Page
Proceedings of the Academy....................1, 183, 319
Rodentia in Evolution, H. L. OSBORN.................. 46
Minnesota species of Laciniaria, E. P. SHELDON.................. 55
Flora of the crest of the Coteau des Prairies, E. P. SHELDON....... 60
The Saint Peter sandstone, F. W. SARDESON.................. 64
The Rum River Valley as a botanical district, E. P. SHELDON...... 88
Fauna of the Magnesian series, F. W. SARDESON.................. 92
Lithology, structure and Genesis of the Magnesian series........ C. W. HALL..................119
Menage Expedition; Letters from D. C. Worcester and F. S. BOURNS..................131
An Orang hunt in Borneo, FRANK S. BOURNS..................173
A mineral resembling meerschaum from Hampden county, Mass., A. D. ROE..................268
Exploration of Verendrye and his sons, 1728 to 1749, WARREN UPHAM..................277
The Psychology of the Business Man, HARLOW GALE..................281
Glacial and modified drift in the Mississippi Valley, WARREN UPHAM..................299
Meteorological statistics, WILLIAM CHENEY and T. S. OUTRAM......305
Conservation of the future Lumber Supply, T. B. WALKER........347
The Prairie Flora of southwestern Minnesota, L. R. MOYER........357
The Prairie Legumes of western Minnesota, L. R. MOYER..........373
Prehistoric Aborigines of Minnesota, N. H. WINCHELL..............378
Hennepin at the Falls of St. Anthony, N. H. WINCHELL............380
The structure of the Universe; Osborne Reynolds' Theory, with portrait of Reynolds; JOHN MACKENZIE..................385
The Evening Grosbeak in Minnesota, T. S. ROBERTS...............406
Extinct Pleistocene mammals of Minnesota. [Two plates] N. H. WINCHELL..................414
Development of the Minneapolis sewer system, ANDREW RINKER....422
Englacial and superglacial drift in Minnesota, WARREN UPHAM...428
Historical Sketch of the Minnesota Academy of Science, HARLOW GALE..................430
Accessions to the Library............2, 20, 33, 184, 195, 202, 221, 229, 237, 246, 252, 260, 442
Revised Constitution and By-Laws..................452
List of Members, December, 1910..................456
Index..................459

OFFICERS—1910

President	T. B. Walker
Vice-President	F. J. Wulling
Secretary	Harlow Gale
Corresponding Secretary	O. W. Oestlund
Curator	J. W. Franzen

TRUSTEES—1910

T. B. Walker, *Ex Officio.*
F. J. Wulling, *Ex Officio.*

Elected 1909—C. W. Hall; Term Expires 1912
Elected 1909—H. Gale; Term Expires 1912
Elected 1910—O. W. Oestlund; Term Expires 1913
Elected 1910—F. W. Sardeson; Term Expires 1913
Elected 1911—N. H. Winchell; Term Expires 1914
Elected 1911—E. C. Gale; Term Expires 1914.

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BULLETIN

OF THE

Minnesota Academy of Natural Sciences

JUN 16 1897
5732

VOL. IV No. 1 PART 1

PROCEEDINGS AND ACCOMPANYING PAPERS 1892-94

WITH SIX PLATES

C. W. HALL EDITOR

MINNEAPOLIS
KIMBALL & STORER CO., PRINTERS
1896

JUN 16 1897

PROCEEDINGS
OF THE
MINNESOTA ACADEMY OF NATURAL SCIENCES

VOLUME IV. BULLETIN I.

January 5, 1892.

ANNUAL MEETING.

Twelve persons present, with Vice President Nachtrieb in the chair.

The following reports of the retiring officers were read and placed on file:

Report of the Recording Secretary:

Report of the Treasurer:

Report of the Corresponding Secretary.

Treasurer Edw. C. Gale made the following financial statement:

Amount on hand at the last annual meeting	$122 92
Membership fees and election dues collected during the year	44 00
Total available for the year	$166 92
Paid to G. A. Clark for typewriting and duplicating	$ 9 50
" Frank White for services	10 00
" J. A. Schlener & Co., stationery	10 50
" N. W. Photo-Engraving Co	2 50
" L. Kimball Printing Co., on acct. of BULLETIN	112 00
Total paid out	$144 50
Balance on hand	$ 22 42

Corresponding Secretary C. S. Fellows reported the following additions to the library during the year 1891:

THE UNITED STATES.

Albany, N. Y.—New York State Library: Bulletins N. Y. State Museum, 2 to 10; Bulletin Legislative, No. 1; Bulletin Regents, Nos. 1 to 7; Bulletin State Library School, 1; Bulletin State Library additions, 1; Bulletin State Library Extension, 1; 73d Annual Report, Sept. 30th, 1890.

Baltimore, Md.—Maryland Academy of Sciences: Transactions, Vol. 1, pp. 1-68.

Johns Hopkins University: Circulars Nos. 69, 72, 74, 77, and Vol. x, Nos. 85 to 94.

Boston, Mass.—Massachusetts Horticultural Society: Transactions, 1889, Part 2, and 1888, Part 1; Schedule of Prizes for 1889 and for 1891.

Boston Society of Natural History: Proceedings, Vol. XXIII, Parts 3 and 4; and Vol. XXV, Parts 1 and 2.

American Academy of Arts and Sciences: Proceedings, Vol. XXV.

Buffalo, N. Y.—Buffalo Historical Society: Annual Reports, Jan. 8, 1889, and Jan. 13, 1891.

Cambridge, Mass.—Museum of Comparative Zoology: Annual Reports, 1890, 1891; Bulletins, Vol. XVI, Nos. 3, 4, 5, 10; Vol. XVII, Nos. 3, 4, 5; Vol. XX, Nos. 4 to 8, and XXI, Nos. 1 to 4.

Chapel Hill, N. C.—Elisha Mitchell Scientific Society; Journal, Vol. VI, Part 1; Vol. VII, Part 2; Vol. VIII, Part 1.

Cincinnati, O.—Cincinnati Society of Natural History: Journal, Vol. XI, Part 4; Vol. XII, Part 1; Vol. XIV, Parts 1 and 2.

Historical and Philosophical Society: Annual Report for 1890.

Columbus, O.—Geological Survey of Ohio: First Annual Report of Third Survey.

Denison, O.—Denison University: Bulletin of Scientific Laboratory, Vol. III and Vol. VI, Part 1.

Davenport, Ia.—Davenport Academy of Natural Sciences: Proceedings, Vol. V, Part 1 (pp. 1 to 184).

Denver, Colo.—Colorado Scientific Society: Proceedings, Vol. III, Part 1.

Hartford, Conn.—Connecticut Historical Society: 250th Anniversary of adoption of First State Constitution.

Iowa City, Iowa.—State Historical Society of Iowa: Iowa Historical Record, Vol. V, and Vol. VII, Parts 2, 3 and 4.

Jefferson City, Mo.—Geological Survey of Missouri: Biennial Report and Bulletins 1 to 5.

Lansing, Mich.—State Agricultural College: 29th Annual Report, and General Index of Reports; Bulletins Nos. 43 to 48 and No. 70; First Report of Forestry Commission, 1887-8.

Lincoln, Neb.—University of Nebraska: University Studies, Vol. I, No. 2.

Little Rock, Ark.—Geological Survey of Arkansas: Annual Report, 1888, Vols. I, II, III.

Madison, Wis.—State Historical Society of Wisconsin: Proceedings of 36th and 38th Annual Meetings, 1889 and 1891.

Meriden, Conn.—Meriden Scientific Association: Transactions, Vol. III (1887-8) and Vol. IV (1889-90).

Middletown, Conn.—Wesleyan University: 18th and 20th Reports of Curator of Museum.

Milwaukee, Wis.—Wisconsin Natural History Society: Proceedings, 1889, pp. 191-231.

Public Museum of the City of Milwaukee: Annual Reports of Trustees, 1883 to 1891 (9 pamphlets); Final Report of Committee on Subscription to Ward Museum Fund, 1885.

Minneapolis, Minn.—University of Minnesota: Annual Report; Bulletin of Agricultural Experiment Station, Nos. 5 to 9 and 16 to 18.

Newark, N. J.—New Jersey Historical Society: Proceedings, Vol. X, No. 3; Vol. XXI, No. 2; New Jersey Archives, First Series, Vols. XIII, XIV; Biographical Sketch of Moses Bigelow.

Geological Survey of New Jersey: Annual Report of Survey, 1889, (and same in German language); Final Report, Vol. II, Parts 1 and 2.

Newport, R. I.—Newport Natural History Society: Proceedings, Document VII.

New York, N. Y.—New York Academy of Sciences: Transactions, Vol. VIII, Parts 1-8; and Vol. X, Parts 1, 2, 3, 4, 5, 6; Index to Vol. IX.

New York Microscopical Society: Journal, Vol. V, 1889, Nos. 1, 2, 3, 4; and Vol. VII, Nos. 2, 3, 4.

Torrey Botanical Club: Bulletin, Vol. XVI, Nos. 1-8 incl., 10, 12; and Vol. XVIII.

American Geographical Society: Bulletin, Vol. XII, No. 4, and Index to Supplement; Bulletin, Vol. XIII, Nos. 1, 2, 3; Bulletin, Vol. XX and Index; Bulletin, Vol. XXI, Nos. 1, 2, 3.

American Museum of Natural History: Bulletin, Vol. II, No. 8; and Vol. III, pp. 41-116, and 123-194; Annual Report of Trustees, 1888-9 and 1890-1.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, 1888, Part III; 1889, Parts I, II; 1890, Part III, and 1891, Part I.

Zoological Society of Philadelphia: 17th Annual Report, 1889, and 19th Report, 1891.

Second Geological Survey of Pennsylvania: Atlas of Southern Anthracite Coal Fields, Parts 3 and 4, AA; Atlas of West Middle Coal Fields, Part 3, AA; Atlas Northern Coal Fields, Part 6, AA, and Parts 3 and 4; South Mountain Sheets, C, 1, 2, 3, 4, and D, 1 to 6; Reports HH and HHH; Museum Catalogue, 3, OOO; Annual Report, 1887; Report of Progress, F, 3; Dictionary of Fossils, Vol. II, N to R; Dictionary of Fossils, Vol. III, S to Z.

Portland, Me.—Portland Society of Natural History: Proceedings of Annual Meeting, May 20th, 1889.

Catalogue of Birds.—N. C. Brown.

Poughkeepsie, N. Y.—Vassar Brothers' Institute: Transactions, Vol. V (1887 to 1890).

Providence, R. I.—Rhode Island Historical Society: Proceedings, 1888-9 and 1890-1.

Rollo, Mo.—Missouri School of Mines: Scientiæ Baccalaureus, Vol. 1, Part 3.

San Diego, Cal.—West American Scientist, C. R. Orcott: The Journal, 1889, No 43, May; 45, July; 46, August; 47, September; 48, October; 49, November.

San Francisco, Cal.—California Academy of Sciences: Proceedings, Series 2, Vol. I, Parts 1, 2; and Vol. III, Part 1.

State Mining Bureau: 8th Annual Report of Bureau; 10th Annual Report and roll of maps.

Saint Louis, Mo.—St. Louis Academy of Sciences: Transactions, Vol. V, Parts 1 and 2, and Total Eclipse of the Sun, Jan. 1, 1891.

Missouri Botanical Garden: Second Annual Report (for 1890).

Saint Paul, Minn.—Minnesota Historical Society: 6th Biennial Report, and Historical Collections; Vol. VI, Part 2.

Salem, Mass.—American Association for Advancement of Science, F. W. Putnam, Permanent Secretary: Proceedings, Vol. XXXVII, Meeting of 1888 at Cleveland; Proceedings, Vol. XXXIX, Meeting of 1891 at Washington.

Topeka, Kan.—Washburn College Laboratory of Natural History: Bulletin, Vol. II, No 9, January, 1889.

Kansas Historical Society: 7th Biennial Report.

Kansas Academy of Science: Transactions, Vol. XII, 1889-90.

Trenton, N. J.—Trenton Natural History Society: Journal, Vol. II, No. 1 (Jan., 1889), and No. 2.

Washington, D. C.—National Academy of Sciences: Report for 1888.

United States National Museum: Annual Reports, 1886, Part 2; 1887, Part 2; 1888, Part 2.

United States Geological Survey: Mineral Resources of the United States, 1887; Monograph XIII, Quicksilver Deposits, Pacific Slope; Monograph XIV, Fossil Fishes and Plants of New Jersey and Connecticut Valley; Bulletins of the Survey, Nos. 48 to 53.

United States Patent Office: Official Gazette for 1891, as issued; Specifications and Drawings, Parts 1 and 2 for May, 1888.

Smithsonian Institution: Report of International Exchanges for year ending June 1888; Mound Explorations, Cyrus Thomas; Ohio Mounds, Cyrus Thomas.

Treasury Department: Production of Gold and Silver in United States, 1887.

United States House of Representatives: 50th Cong., 1st Session; President's Message, Ex. Doc. 434.

United States Senate: 50th Cong., 1st Session; President's Message, Ex. Doc. No. 51; 50th Cong., Fisheries Treaty, Message, Doc. 109; 50th Cong., President's Opening Message; 50th Cong., 2d Session, Congressional Directory.

FOREIGN.

Altenberg, Ger.—Naturforschende Gesellschaft des Osterlands: Mittheilungen-Baende 3 and 4.

Amiens, France.—Société Linnéenne du Nord de la France: Bulletin, Tome x, Nos. 211 to 222.

Amsterdam, Neth.—Koninklijke Zoologisch Genootschap, Natura Artis Magistra; Bij tot de Dierkunde, No. 1; Neder tyd Voor de Dierkünde Jahrgang, v, Af. 1; Bij dragentot de Dierkunde, Af. 10-14 and 16.

Bamburg, Bavaria.—Naturforschende Gesellschaft. Bericht xv.

Barcelona, Spain.—Royal Academy of Natural Sciences and Arts: Memoria Inaugural, 1888-9.

Berlin, Prussia.—R. Friedlander u. Sohn: Naturæ Novitates, 1889, Nos. 1, 2, 3, 6, 7, 8, 11, 13, 14, 16, 17, 18, 19, 20, 22, 23.

Königliches Meteorologisches Institut: Abhandlung Band 1, Nos. 1, 2, 3; Observ. bei Potsdam (report 1890); Deutsch Meteorol. Jahrbuch for 1888, 1890 (Heft 2), 1891 (Heft. 1).

Bern, Switz.—Société Elvetica delle Scienze Naturali: Verhandlungen 73, Session 1889-90.

Schweizerische Entomologische Gesellschaft: Mittheilungen, Vol. viii, Heft 1 to 5, and 7-8.

Beziers, Fr.—Société d'Etudes des Sciences Naturelles de Beziers: Bulletin, Vols. xi and xii (1888, 1889).

Bombay, India.—Royal Asiatic Society (Bombay Branch): Journal, Vol. xvii, No. 47, Part 2; Journal, Vol. xviii, No. 48.

Bone, Algeria.—Académie d'Hippone, Soc. de Recherche Scientif. et d'Acclimatation: Comptes Rendus, 1888-91 (4 Vols.).

Bremen, Ger.—Naturwissenschaftlicher Verein: Abhandlungen, Band xii, Heft 1.

Brisbane, Australia.—Queensland Museum of Natural History: Annual Report of Trustees, and Annals, No. 1.

Brussels, Belgium.—Société Belge de Microscopie: Bulletin, 16th year, Nos. 2, 3, 4, and 17th year Nos.; Annals, Tome xv.

Société Malacologique de Belgique: Proces Verbal de Sciences, pp. 133 to 216, Tome xviii; Proces Verbal de Sciences, pp. 1 to 88, Tome xix, and Proceedings, Vol. xvii, pp. 1 to 72.

Buenos Ayres, Arg. Rep.—Museo Publico de Buenos Aires: Bulletin—Memoir de Museo de prod. Argentina.

Sociedad Cientifica Argentina: Anales, Tomo xxx, Entrega vi, pp. 433-528; Anales, Tomo xxxi, Entrega i-v; Anales, Tomo xxxii, Entrega i-iii.

Cairo, Egypt.—Institut Egyptien: Bulletin, 3d Series, No. 1, 1890; Memoires, Tome ii, Parts 1, 2; Bulletin, 2d Series' No. 9.

Calcutta, India.—Geological Survey of Indica: Bibliography of Indian Geology; Records, Vol. xxii, Parts 1, 2; and Vol. xxiii, Parts 1, 2, 3; Table of Contents and Index of first twenty Vols. of Records; Memoirs, Vol. xxiii; Palæontologia Indica, Series 13, Vol. iv, Part 2.

Cardiff, England.—Naturalists' Society: Report and Transactions, Vol. xii, Parts 1, 2.

Catania, Italy.—Accademia Giocnia Scienze Naturali: Atti Anno, lxvi, 1889-90, Vol. ii; Bollettino Mensuel, Fasc. xvi, xxii.

Christiania, Norway.—Videnskabs Selskabet: Oversigt, 1887, and for 1888 and 1890.

Det Kongelinge Norske Fredericks Universitet: For. v. de Skandinaviske Naturforskers, 30th year, 1886.

Cordoba, Arg. Rep.—Academia Nacional de Crencias Exactes: Bulletin, Tomo ii, No. 3.

Dorpat, Russia—Naturforscher Gesellschaft, Universitat: Sitzungsberichte, 1890.

Dresden, Saxony.—Naturwissenschaftliche Gesellschaft: Sitzungsberichte, Abhandlungen, 1890, July-December.

Dumfries, Scotland.—Dumfriesshire and Galloway Nat. Hist. and Antiqu., Society: Transactions, 1887-90.

Florence, Italy.—Istituto di Studi Superiori: Archivis Senola d'Anatomia patologica, Vol. ii.

Esegesi medico legale del methodus testicandi di Gio Batta Codrouchi. A. Filippi.

Linee generali sulla fisiologia del cervelletto, Mem. 1.—L. Luciani.

Osservarioni continue sull elettricite atmospherica, Mem. 1.—Rothe Pasqualini.

Biblioteca Nazionali: Bulletins 79-94; Index to Bulletins for 1888, pp. 1-112; general Index, 1887; Title page and General Index for 1888.

Fribourg, Switz.—Société Fribourgeoise des Sciences Naturelles: Bulletins, 1879-80 to 1883-87 (4 Vols.).

Geneva, Switz.—Société de Géographie: "Le Globe," Tome xxx, Nos. 1, 2.

Georgetown, Br. Gui.—Royal Agricultural and Commercial Society: "Timehri," Vol. iv, Part 2; Vol. v, Part 1.

Glasgow, Scotland.—Geological Society: Transactions, Vol. viii, Part 2, and Vol. ix, Part 1, 1888-9, 1889-90.

Gratz, Austria.—Naturwissenschaftlicher Verein für Steiermark: Mittheilungen, 1890.

Greifswald, Pruss.—Naturwissenschaftlicher Verein von Neuvorpommern u. Rügen: Mittheilungen, 22te Jahrgong (1890).

Gueret, France.—Société des Sciences Naturelles et Archeologiques de la Creuse: Memoires, Tome 1; Bulletin 4 (1890).

Haarlem, Neth.—Musée Teyler, Fondation de P. Teyler van der Hulst: Archives, Serie iii, Vol. iii, Parts 5 and 6.

Halifax, N. S.—Nova Scotia Institute of Natural Sciences: Proceedings and Transactions, Vol. iv, Part 3; Vol. v, Part 4; Vol. vi, Parts 3, 4, and Vol. vii, Parts 1, 4.

Halle, Prussia.—K. Imper. Leopoldina Carolina Akad. der Deutsches Naturforscher: "Leopoldina," Heft 24 to 26; Nova Acta, Vol. lv, No. 4; Zincken Gasvorkommen.

Hamburg, Germany.—Naturwissenschaftlicher Verein, Hamburg-Altona: Abhandlungen, Vol. xi, Nos. 2, 3: Verhandlungen, Band i to vi, 1871 to 1885.

Hamilton, Can.—Hamilton Association: Journal and Proceedings for Session 1890-91, Part VII.

Kassel, Prussia.—Verein für Naturkunde: Reports, 1886 to 1888, and 1889, 1890.

Kazan, Russia.—Obshchestvo Iestestvo—Ispytatelei pri Imp. Kaz. Universitaten: Memoirs, Tomb XXI, XXII and XXIII, No. 2.

Liverpool, Eng. Geological Society: Proceedings, Vol. VI, Parts 1 and 3.

Lyons, France.—Société Linnéenne de Lyon: Annales, Vols. XXXII (1885), XXXIII (1886), XXXIV (1887).

Manchester, Eng.—Literary and Philosophical Society: Memoirs and Proceedings, Vol. IV, Nos. 1 to 5.

Field Naturalists and Archæologists' Society: Report and Proceedings, 1890.

Melbourne, Austr.—Royal Geographical Society of Australia: Transactions, Vol. VIII, Part 2, and Vol. IX, Part 1.

Public Library, Museums and National Gallery: Prodromus of Zoology of Victoria, Decades 16, 17, 18, 20; Reports of Trustees, 1887 and 1889.

Mexico, Mex.—Sociedad Mex. de Geografia y Estadistica; Bulletin, 4th series, Vol. I, Nos. 3 and 4.

Observatorio Meteorologico Central: Boletin Mensual, Tomo III, Num. 2.

Montreal, Can.—Natural History Society: Canadian Record of Science, Vol. III, Nos. 3, 4, 5, 6; and Vol. IV, No. 7.

Moscow, Russia—Société Imperial des Naturalistes de Moscow: Bulletin, 1888, Nos. 3, 4; 1889, No. 1; and 1890, Parts 2, 3, 4; Meteorological supplement to Parts 1 and 2.

Munster, Prussia.—Provinzial Verein für Wissenschaft u. Kunst: Annual Reports No. 16 (1887), and 18 (1889).

Osnabruck, Pruss.—Naturwissenschaftlicher Verein: 8th Jahresbericht, 1889-90.

Ottawa, Can.—Geological and Nat. Hist. Survey of Canada: Annual Report, Vol. IV, New Series, 1888-9.

Penzance, Eng.—Natural History and Antiquarian Society: Report and Transactions, 1890-1.

Pisa, Italy.—Societa Toscana di Scienze Naturali: Processi-verbali, Vol. VII, pp. 199-234.

Rio Janeiro, Brazil.—Instituto Historico, Geografico y Ethnografico: Revista Trimensal, Vol. LII, Part 1; Vol. LIII, Part 2; Vol. LIV, Part 1.

Rome, Italy.—Biblioteca Nazionale Vittorio Emanuele: Bollettino, Vol. III, Nos. 5 and 6, and Title Page and Index; Bollettino, Vol. IV, Nos. 1, 2, 3; Vol. V, No. 4; Vol. VI, Nos. 1 to 11; Index Alfabetico.

Rostock, Germany.—Verein der Freunde, der Naturgeschichte; Archiv 45te, Jahrgang (1891) 1 Abtheilung.

Rovereto, Austria.—I. R. Accademia di Lettere e Scienze degli Agaiti: Atti, 1890.

St. Gall, Switz.—Naturwissenschaftliche Gesellschaft: Bericht ueber d. Thätigkeit, 1888-9.

St. Johns, N. B.—Natural History Society of New Brunswick: Bulletins Nos. 8 and 9, and Index to Bulletins 1 to 5.

St. Lo, France.—Société d'Agriculture, d'Archeologie et d'Histoire Naturelli de la Manche: Notices, Memoires et Documents, 9th Volume.

Semur, France.—Société des Sciences Historiques et Naturelles de Semur: Bulletin, 2d Series, No. 4, 1889.

Shanghai, China.—Royal Asiatic Society (China Branch); Journal, Vol. XXII, No. 6; and Vol. XXIII, Nos. 1, 2, 3.

Stavanger, Norway.—Stavanger Museum: Aarsberetning for 1890.

Strassburg, Germany.—Kom, für die Geologische Landes Untersuchung: Mittheilungen Band I, II and III, No. 1.

Sydney, N. S. Wales.—Geographical Survey of New South Wales: Memoirs of the Survey; Paleontology, No. 2 and No. 7; Records of the Survey, Vol. I, Parts 1 and 2, and Vol. II, Part 2; Annual Report of Department of Mines, 1890; Descriptive Catalog of Exhibits of Metals, Minerals, &c., to the Melbourne Cen. International Exhibition, 1888.

Royal Society of New South Wales: Journal and Proceedings, Vol. XXII, Parts 1 and 2; and Vol. XXIV, Parts 1 and 2.

Tókio, Japan.—Deutsche Gesellschaft für Natur und Volkerkunde Ostasiens: Mittheilungen, Heft 46.

Toronto, Canada.—Canadian Institute: Proceedings, 3d Series, Vol. VI, No. 2; Transactions, No. 1, Vol. I, Part 1; Transactions, No. 2, Vol. I, Part 2; Transactions, No. 3, Vol. II, Part 1; Report for 1887 and Maps; Fourth Annual Report, 1890-1.

Time Reckoning for the 20th Century.—Sanford Fleming.

Toulouse, France.—Acad. des Sciences, Inscriptions et Belles-Lettres de Toulouse: Memoirs, New Series, Tome II, 1890.

Townsvill, Australia.—Geological Survey of Queensland: Report of Annual Progress, 1889.

Chillagoe and Koorboora Mining Dists., from J. S. Jack, Author.

Turin, Italy.—R. Museo Zoologico di Torino: Bollettino, Vol. III, Nos. 49 to 52, and Plate No. 3; Vol. IV, Nos. 53 to 61 and Plate No. 1; Vol. V, Nos. 87 to 93, title and index; Vol. VI, Nos. 94 to 103.

Vienna, Austria.—Verein der Geographen an der K. K. Universität: Bericht u. d., XVI Vereinjahr.

Wiesbaden, Pruss.—Verein für Naturkunde: Jahrbücher, Jahr. 44.

The following officers were elected for the year:

President, - - - -	Henry F. Nachtrieb.
Vice-President, - - -	Thomas S. Roberts.
Recording Secretary, - -	Christopher W. Hall.
Treasurer, - - - -	Edward C. Gale.
Corresponding Secretary,	William H. Pratt.
Trustees for three years,	Louis F. Menage. S. P. Channell.

February 2, 1892.

Regular monthly meeting.

Fifteen persons present.

Prof. H. L. Osborn read a paper on "The rodentia in evolution; a preliminary study." [See paper A.]

A letter dated November 12, 1892, from Mr. D. C. Worcester, of the Menage Scientific Expedition to the Philippine Islands was then read by Secretary Hall. Following this, President Nachtrieb read the description of a new species belonging to the family Lemuroidea, sent by Mr. Worcester for prompt publication. An abstract of the description has been published in the *Zoologische Anzeiger*. No. 389, 1892.

The following were elected members. Prof. W. R. Appleby, Charles P. Berkey, and Arthur H. Elftman, all of the University of Minnesota.

March 8, 1892.

Twenty-three persons present.

The following papers were presented:

Notes on the genus *Laciniaria* in Minnesota, by E. P. Sheldon. [See paper B.]

The classification of the Metaphyta by Prof. Conway MacMillan.

[ABSTRACT.]

In this paper an attempt is made to indicate the dual nature of the species among higher plants, in which both sporophytic and gametophytic structures may be distinguished, upon the presence or absence of the sporophyte, plants are classified into *Gamophyta* and *Sporophyta* and the subdivisions of these groups are indicated. The futility of attempts to homologize, after the ordinary manner, higher plants with higher animals is pointed out and the proper course in the search after a basis for comparison between the two principal phyla of living things is suggested. The paper is published in full in Vol. XVII, pp. 108-113 of the *Botanical Gazette* (1892).

Current methods in botanical instruction by Professor MacMillan.

[ABSTRACT.]

The ordinary attitude of educators towards the science of botany is described and criticised. A plea is entered for the emancipation of botany from its bonds to medicine and the establishment of it, as physics or chemistry, upon a pure basis, where the *knowledge* of the plant rather than the

classification of the plant should be deemed important. The methods of botanical instruction, or what too often passes for it in American schools, colleges and universities, are discussed and the better developments in some particularly fortunate institutions are briefly chronicled. In conclusion the constructive work and influence of men like Draper or Bessey is considered and an effort is made to show the urgent need of a still more widespread reform. The paper is published in full in *Education*, March, 1892.

Preliminary notes on the influence of anæsthetics on plant transpiration, by Dr. A. Schneider.

[ABSTRACT.]

The paper gives a brief review and criticism of Jumelle's memoir on the same subject. Jumelle came to the conclusion that ether increases transpiration in the light, but decreases it in the dark. The increase in light is supposed to be due to the influence of ether on assimilation. Ether decreases assimilation and hence those rays of the sun which were engaged in assimilation are now utilized in "chlorophyllian transpiration." Lommen, in 1891, made a series of experiments which apparently verified Jumelle's conclusions.

Jumelle's as well as Lommen's experiments are insufficient because they used only parts of plants (leaves and branches), and in that they confounded *evaporation* and *transpiration.*

In the writer's experiments, a modified and improved Kohl transpiration apparatus was used which allowed the use of the entire plant, root and all. Various anaesthetics as ether, chloroform and amyl-nitrite were used. The effect of ether on protoplasmic movements in hair cells of *Primula sinensis, Petunia violacea*, and *Lycopersicum esculentum* was carefully noted. The influence of the various colors of the solar spectrum on transpiration under normal conditions and combined with the anaesthetics was then taken up and also the influence of anaesthetics with moisture. Finally a series of control experiments was made with leaflets of *Solanum tuberosum.*

The summing up of all the results obtained led to the following conclusions:

1. Ether retards protoplasmic action. Given in sufficient doses it kills protoplasm.
2. Ether *retards* transpiration by *retarding* assimilation.
3. Ether retards transpiration in both light and darkness, in fact, under all conditions.
4. The increased loss of water vapor by the anaestheticized vegetable tissue is due to the fact that the anaesthetic has modified the primordial utricle, thus allowing *evaporation* to take place, and not *transpiration.*
5. Periods of maximum transpiration and assimilation coincide.

James W. Swan, White Bear Beach, and Professor I. H. Orcutt, Brookings, South Dakota, were elected members.

April 5, 1892.

Twelve persons present.

The papers read were:

Notes on the Alpine characteristics of the flora of the Coteau des Prairies, by E. P. Sheldon. [See paper C.]

Some poisonous plants around Winona, Minnesota, with descriptions of their characters, by C. W. McCurdy, read by Professor Conway MacMillan.

[ABSTRACT.]

Attention is called to the poisonous properties of the following plants which are either native or introduced in the neighborhood of Winona, Minn.: *Actara spicata* Linn., *Aconitum napellus* Linn., *Ranunculus sceleratus* Linn., *Hellborus niger* Linn., *Rhus toxicodendron* Linn., *Rhus venenota* D. C., *Solanum nigrum* Linn., *Atropa belladonna* Linn., *Solanum dulcamara* Linn., *Hyoscyamus niger* Linn., *Datura stramonium* Linn., *Pastinaca sativa* Linn., *Conium maculatum* Linn., *Cicuta maculata* Linn., *Archemora rigida* D. C., *Aethusa cynapium* Linn., *Taxus baccata* Linn., *Kalmia augustifolia* Linn., *Symplocarpus fortidus* Nutt., *Arisaema triphyllum* Torr., *Digitalis purpurea* Linn., *Lobelia inflata* Linn., *Phytolacca decandra* Linn., *Urtica gracilis* Ait., *Andromedo mariana* Linn. The frequent occurrence of poisonous Agarics is also noted and it is recorded that the flesh of edible toadstools does not become discolored when broken, while that of the poisonous species quickly changes to a deep blue or purple color.

O. A. Stoneman was elected a member of the Academy.

May 3, 1892.

Eighteen persons present.

The papers presented were the following:

Motion and life by Professor L. W. Chaney.

Remarks on some recent investigations on Phagocytes; and the relation of Protozoa to disease, by Professor Henry F. Nachtrieb.

[ABSTRACT.]

Metchnikoff's recent valuable contributions to our knowledge of phagocytes were briefly reviewed and their importance pointed out.

The last edition of Pfeiffer's "Die Protozoen als Krankheiterreger" was briefly reviewed and compared to some of the earlier works on Bacteriology in that the subject was still in a rather chaotic condition and at the same time was full of promise. The subject undoubtedly is one of great importance. It is also one of great difficulty, possibly is surrounded by greater difficulties than Bacteriology was in its earlier days, since it is impossible at present to cultivate any of the various protozoa that are cell parasites

—that is, parasites within the individual cells of the body. More experiments, larger knowledge and improved technique may, however, soon remove this apparently insurmountable barrier.

Recent views concerning the embryo-sac of Angiosperms and the cells produced by it, by Professor Conway MacMillan.

[ABSTRACT.]

Current discussion concerning the homologies of the Metaspermic embryo-sac is somewhat clarified by recent papers of Guignard, Hartog, Bretland-Farmer, and others. The notion that the endosporic cells are not in the nature of a female gametophytic plant has been again argued by Guignard, upon the bases of his researches concerning the number of chromatomeres in the equatorial plane of vegetative and reproductive nuclei. This view has already, from other morphological evidence, been advanced by Warming, Vesque and Mann, but is, on the whole, not to be credited because of the distinct homologies with the embryo-sac of Archispermous plants, like Cycas, where the embryo-sac is clearly a megaspore, and on account of other and simple explanations of the number of nuclear segments in the definitive nucleus of the sac before the divisions of germination.

Considering the embryo-sac in all cases then, as a spore and not as a special spore-mother-cell, it becomes evident that the traditional explanation of the seven cells which are produced within it in the Metaspermæ is not far from the truth. They represent a degraded and symbiotic sexual plant, forming the female of the same generation as that in which the pollen-tube is the symbiotic male.

The older view that the antipodal cells represent the prothallium of the female plant is, however, not to be maintained, and in evidence the results of certain examinations of different pollen-tubes and embryo-sac contents were adduced. It will be found that in the case of *Narcissus, Cucurbita* and others, the staining of the second polar cell of the egg and that of the sperm nucleus is similar in all points, and that in structure, size and reactions to safranin, dahlia and other dyes, these nuclei are readily comparable. On the other hand, the antipodal cell that migrates to the top of the embryo-sac, where it finally fuses with the second polar cell of the egg, otherwise known as the micropylar endosperm-forming nucleus, is comparable more directly with the other micropylar cell which is universally recognized as having the character of an egg. In size, structure and chemism, these cells are similar. It therefore appears that the antipodal cells, as is determined by Hartog, upon a purely theoretical basis, are *experimentally* seen to have the character, not of prothallium, but of an archegonium, and the embryo-sacs of Metaspermæ are *universally characterized by the production of two eggs.* One of these is cross-fertilized by the sperm nucleus of the pollen-tube, and develops the embryo of the seed. The other is close-fertilized by the polar body of the micropylar egg and develops a dependent sporophytic plant, the endosperm, and this is destroyed, either during processes of seed-ripening or of seed germination, in both of which it comes into competition with the more robust cross-fertilized sporophyte. It is apparent then that polyembryony is the rule among the Metaspermæ and that every seed, at some time in its life (with the possible exception of some orchids), bears within its coats two plants, only one of which has the strength to develop into an embryo and ultimately into a seedling and mature sporophytic structure.

It is maintained then, that the Metaspermæ are peculiarly characterized by persistent specific dimorphism of a high grade and this alone serves to limit them from all other living things. Each specific form consists of four potential individuals, where the dimorphism is at its height. These are (*a*) the male plant or pollen-tube, (*b*) the female plant or embryo-sac contents (and in the Metaspermæ the female is binovular), (*c*) the staminate, sporophytic plant of vegetative specialization, and (*d*) the pistillate, sporophytic plant—also of vegetative specialization.

S. P. Channell presented a beautiful piece of Sphalerite from Joplin, Mo., for which the secretary was directed to extend the thanks of the Academy.

The meeting adjourned until the second Tuesday in June instead of the first, as regularly, owing to the Republican National Convention.

June 14, 1892.

At this meeting there was no quorum, but Mr. Uly S. Grant presented a paper on "The stratigraphical position of the Ogishke Muncie conglomerate of northeastern Minnesota,"* of which the following is an

[ABSTRACT.]

A brief review of the first description of this great conglomerate is given, followed by a summary of the opinions of the geologists who have worked in this region, in regard to the relation of this formation to the surrounding rocks. The relation of the conglomerate to the rocks in its immediate vicinity, and especially to the Saganaga granite, was discussed and the following conclusions arrived at: The Ogishke Muncie conglomerate can no longer be correlated with the Animikie, as has often been done, for the two are separated by a great structural break and an immense erosion interval. The conglomerate grades, both along and across the strike, into rocks which have as yet not been separated from the Keewatin series. At present it seems best to regard the conglomerate as an upper member of the Keewatin.

October 4, 1892.

Twelve persons present.

The following program was heard:

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*This paper is published in the American Geologist for July, 1892, pp. 4-10.

Notes on an excursion into northern Mexico.—A. D. Meeds.

[ABSTRACT.]

On October 4, 1891, the writer having been granted a leave of absence from the University of Minnesota, left Minneapolis for El Paso, Texas, where he joined Dr. Carl Lumholtz, the Norwegian explorer, who was about to continue his expedition in northern Mexico. The expedition* had started the previous year from Bisbee, Arizona, and at this time the party was near Casas Grandes, in northwestern Chihuahua, where they had spent the summer exploring the many ruins and mounds of the early inhabitants. A very valuable collection of pottery, utensils, etc., was made and sent to the American Museum of Natural History, New York, under whose auspices the expedition was undertaken.

The general object was to explore and study the prehistoric ruins, to make collections of animal and plant life, and of rocks and minerals, in order to advance our knowledge of an unmapped and little known territory. The region to be explored was in the inaccessible Sierra Madre mountains lying along the boundary between the states of Sonora and Chihuahua, in northern Mexico. These mountains from their ruggedness had been the lurking place of hostile bands of Indians, especially Apaches, who had terrorized the surrounding country, carrying death and destruction into the pueblos and driving all settlers out of the country. They had been masters of the region for many years and were only captured and dislodged by Gen. Crook in his famous campaign.

The early Spaniards had been through this country centuries before and had left traces in the way of abandoned smelters, mines, etc. The Mexicans told fabulous stories of this wonderful country. It had been reported and was believed by some scientific men, that a tribe of Cliff Dwellers still existed in their natural state, in the barrancas of this *terra incognita*.

Casas Grandes is about 150 miles directly south of Deming, N. M., where the explorers left the railroad, and about the same distance southwest of El Paso, Texas. It is on a river of the same name which flows through the sandy plain, enclosed on the east and west by mountains. The topography of the country is very similar to that of Texas and New Mexico, of which it is, in fact, a continuation. From this point the expedition traveled in a southerly direction, climbing immediately into the mountains and continuing along their crests the greater part of the time. These mountains vary from 6,000 to 9,000 feet high, and during the winter are covered with snow, the weather at this time being very similar to a mild Minnesota winter.

The party consisted of the leader, Dr. Carl Lumholtz, G. H. Taylor, topographer and photographer, C. V. Hartman, botanist, J. H. Locke, in charge of accounts, A. D. Meads, naturalist, and about a dozen Mexicans for general work.

Leaving Casas Grandes, about 4,500 feet above sea level, the region of the pines was reached, ranging from 6,000 to over 8,000 feet, and a few days brought the party to the Mormon colony of Bacheco located in a small valley or plain in the mountains. This was the last settlement seen for about a month. Mount Chuhuichupa was passed, where Gen. Crook had captured the Apaches, and the great difficulties and dangers he must have encountered were here realized. Traveling was very difficult and slow and attended by great danger in the roughest part of the mountains. The fall of an animal down some steep cliff became a common occurrence. The scenery was full of grandeur. In the very heart of this region were passed the ruins of smelters built by the early Spaniards who had worked the mines at Guaynopa and other points which are now abandoned.

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*See account of the Expedition in Scribner's Magazine, November, 1891.

The party soon left this wild region, striking the town of Temosachie, on the main traveled trail to the mining district of Pinos Altos. The trails were fairly good through the mining towns of Pinos Altos and Jesus Maria, and various small pueblos on the road to Batopilas These pueblos were inhabited partly by Mexicans and partly by Indians, all very poor and possessing a very low order of intelligence. The Indians encountered were mostly Tarahumaras, who raise flocks of sheep and goats and cultivate small plats of land on the mountain slopes and in the valleys, and are usually honest and peaceful.

Before reaching Batopilas another extremely rough country was traversed in the Barranca de Cobre, where an English company is working an old mine. The cañon here is about 4,000 feet deep, and the trails are very steep and dangerous. Batopilas is about a week's journey from here and is situated on a river at the bottom of a deep cañon, about 2,500 feet above sea level. It is in the southwestern corner of Chihuahua, near the states of Julisco and Durango. It is one of the largest and richest mines in the state and is owned by Americans. At this point, which is in the neighborhood of 400 miles south of Deming, but in reaching which probably double that distance was traveled, the party was disbanded in May, 1892. Dr. Lumholtz decided that the main object of the expedition, the proof of the existence or non-existence of Cliff Dwellers, could be better accomplished by his traveling alone, obtaining Indian guides as he found it necessary. A full account of the expedition will probably be published in the Bulletin of the American Geograpical Society, New York, when Dr. Lumholtz finally completes his exploration. He contemplates publishing a book describing the people and country, with incidents of the expedition.

Observations on the collections of minute aquatic forms made by Messrs. Worcester and Bourns in the Philippine Islands, by Chas. S. Fellows.

[ABSTRACT.]

At the writer's suggestion, on their expedition to the Philippine Islands Messrs. Worcester and Bourns took with them apparatus especially designed for the collection and preservation of minute aquatic forms.

Unfortunately the apparatus was lost, and in the early part of their stay no collections of these forms were made.

After new apparatus was received they were enabled to collect and send eleven small gatherings, five of which were from fresh water and the remainder from brackish and salt water.

The collections were all made at and near Puerto Prinusa, Paragua (Palawan) during December, 1891, and February, 1892.

From the fresh water gathering were found one species of Ostracoda (undetermined); two of Cladocera, *Daphnella* and *Bosmina* (only two specimens of the former and one of the latter have as yet been recognized). There were found of the Copepoda, one species of *Cyclops* and one of *Diaptomus*, the latter new to science.

The salt water gathering yields one new genus, a calanid, and seven species of as many genera, as follows: *Ectinosoma*, *Amymone*, *Laophoute*, *Westwoodia*, *Harpacticus*, *Porcellidium* and *Lichomolgus*.

It is a curious circumstance that although the "Challenger" made no less than four gatherings at the Philippine Islands, one of which was in the harbor of Zeba where the above forms would likely be found, only one was then found, *Ectinosoma*, a single specimen of which was secured and that at Ascention Island.

Several species of Amphopods were found but have not as yet been studied.

The collections are now receiving a thorough examination and will be fully reported upon shortly. Only a few mature specimens have as yet been detected among the fresh water forms and a further supply of material is awaited that the forms may receive more thorough examination.

Secretary Hall gave an outline of recent news received from the Menage Scientific Expedition; also an account of the present state of the taxidermic work of Mr. Hobson.

The meeting was then adjourned to the second Tuesday instead of the first in November an account of election day.

November 13, 1892.

Twenty-one persons present.

Three papers were read:

Outlook for a cholera epidemic in 1893, by Dr. A. Schneider.

[ABSTRACT.]

In this paper the author criticises American carelessness and incompetence to cope with great epidemics. The first part of the paper was devoted to a short review of the history of various cholera epidemics since 1817, after which was given some of the evidence of the most prominent cholera bacteriologists as Koch, Hueppe, Fraenkel and others. Missionaries, ministers and other non-professionals are severely criticised for expressing erroneous opinions in regard to the prevention and treatment of cholera.

The main feature of the paper is the cholera outlook in 1893. Owing to

the fact that cholera has already made its appearance and that it usually continues its ravages for several years it can be expected to make its appearance the coming year, especially if the weather be moist and warm. Knowing that cholera follows the routes of commerce and knowing that there will be an enormous increase of traffic and immigration on account of the Columbian World's Fair in Chicago, a cholera epidemic is thereby much more liable to occur. The cities near the St. Lawrence river, the great lakes, the Atlantic and Gulf of Mexico will be particularly exposed.

The writer does not attach any special importance to arresting immigration unless all commercial intercourse were also stopped and that would be more harmful than the epidemic itself. The plan suggested is to appoint thoroughly qualified national health officers with police authority to look after the sanitary conditions of every city in the Union. This should begin *now* and not after the cholera has made its appearance. Cholera can be easily prevented if proper precautions are taken, and even after it has made its appearance it is easily controlled under proper treatment.

A map accompanied the paper showing the probable routes and distribution of cholera in 1893.

This paper was discussed by Dr. E. S. Kelley, health officer of Minneapolis, and others.

The Saint Peter sandstone by F. W. Sardeson. [See Paper D.]

The Rum river valley as a botanical district, by E. P. Sheldon; read for the author, by C. A. Ballard. [See paper E.]

December 6, 1892.

Twenty persons were present.

Corresponding Secretary W. H. Pratt, presided.

The following program was carried out:

A review of some points in the history of microscopy, by Chas. P. Berkey.

The subject was treated for the most part historically. The object was to note the early inventions of lenses, and to trace the various subsequent important improvements in both simple magnifiers and in combinations up to the early part of the present century. A chart was used to illustrate the appearance and adjustment of Leeuwenhoek's simple microscopes. In conclusion the paper outlined some of the late improvements and called attention to the broadened usefulness of the instrument in the last fifty years.

The use of the microscope in the study of the plant lice. —O. W. Oestlund.

[ABSTRACT.]

Attention was called to the insufficiency of the characters generally used by entomologists for the distinction of species of the aphididæ as the number

is constantly increasing. In the wings we have good characters for genera and higher groups, but usually of little use for species. The relative length of the joints of the antennæ are subject to too great variation to be much relied upon. A knowledge of the food-plant is not sufficient as exceptions are constantly being brought to light. Color is in all the larger genera, where specific characters are most needed, of little value. It therefore, in many cases, becomes necessary to seek for additional characters to those commonly given.

A study of mounted specimens under the microscope brings out several characters that promise to be of great value, at least for the more difficult genera, one of the most important of which are the *sensoria*, or small sense spots distributed over the surface of the antennæ, which have been found quite constant, both in size, number and distribution. A summary of the results of a study of the sensoria of the Minnesota species was given; a full account of which will appear in a final report on this family in the publications of the Geological and Natural History Survey of Minnesota.

A new locality for cobalt in Minnesota, by A. D. Meeds.

[ABSTRACT.]

While examining a sample of manganese ore from Monticello, Minn., indications of cobalt were noticed and further examination proved it to be present in small quantity. As cobalt had not been reported from Minnesota before, so far as known, a determination of the cobalt was made. The ore under examination was a bog ore and contained much organic matter. It was first ignited and the ash submitted to partial analysis, resulting as follows:

Manganese, Mn.,	35.70
Iron and Alumina, Al_2O_3, Fe_2O_3,	4.63
Cobalt Oxide, $Co\,O$,	0.71
Insoluble, $Si\,O_2$,	28.33

Cobalt in small quantity seems to be quite constant in its occurrence in bog manganese ores and its appearance here is not surprising.

Although a number of samples of manganese ore from Monticello have been examined, this is the only one so far that has shown any sign of cobalt.

This paper was discussed briefly by H. V. Winchell, who stated that recently obtained samples of pyrrhotite from the lower part of the Huronian series near Gunflint lake, T. 65, R. 4 W., had been found to contain traces of cobalt and about three per cent. of nickel. This is supposed to be at the same geological horizon as the Sudbury, Ont., nickel deposits.

The Fauna of the Magnesian Series of the northwestern states; with descriptions of new species by F. W. Sardeson. [See paper F.]

The structure, lithology and genesis of the Magnesian Series of the northwestern states, by C. W. Hall. [See paper G.]

Supt. Robert P. A. Nix, New Ulm, Minn., Prof. W. V.

Metcalf, Northfield, Minn., Prof. Philip Smith, Faribault, Minn., and Dr. Walter C. Hanscom, Minneapolis, were elected members.

Secretary Hall introduced the following resolution:

> Resolved, That this Academy, always aiming to advance scientific knowledge and culture in the community, shall secure for the coming winter a series, three to six in number, of lectures from our members. These lectures will treat the subjects which they discuss in a somewhat more popular manner than our monthly programs are accustomed to do.

The resolution was unanimously carried, and President Nachtrieb and W. H. Pratt were directed to appoint a committee of three to secure the lecturers and arrange the meetings for the same.

January 3, 1893.

ANNUAL MEETING.

President Nachtrieb in the chair.

Sixteen persons present.

The report of the following officers were read:

Report of Recording Secretary Hall; the first part touching the scientific work of the Academy, was ordered filed, and the second part, giving the statement of dues and collections, was referred to the auditing committee.

The report of the Treasurer, E. C. Gale, was then read:

SUMMARY OF TREASURER'S REPORT FOR THE YEAR 1892.

1892.			
Jan. 5	By Balance from 1891		$17 42
Jan. 5,'92 to Jan. 3,'93	Collections of Annual dues through Prof. Hall		304 00
Feb. 22	R. J. Mendenhall, on life membership		10 00
Mch. 11	Bishop McGolrick, on life membership		50 00
Feb. 23	Judge Vanderburgh, for Cross Collection		10 00
Jan. 5,'93	T. B. Walker, for Menage Collection, taxidermy		390 00
	CONTRA.		
Feb. 4	To Cash to Kimball, for printing	$150 00	
Mch. 4	Cash to Rev. R. T. Cross, for collection	45 00	
Mch. 25	Certificate deposit, Permanent fund	60 00	
	N. W. Photogravure Co., for plates	43 25	
	J. Hobson, for taxidermist services	418 10	
	J. Hobson, for taxidermist supplies	27 42	
	Typewriting and office sundries	18 16	
	Express and Miscellaneous expenses	29 85	
	Deficit, balance due Treasury		10 36
		$791 78	$791 78

The report of the corresponding secretary was read. Mr. Pratt reported the number of additions from the United States to be 224; from foreign countries, 396; total, 620 titles, as follows:

THE UNITED STATES.

Albany, N. Y.—State Museum of N. Y.: Bulletin, Vol. I, No. 1; 44th Annual Report, Bound.

University of the State of New York: State Library Bulletin, No. 2; 104th Report of Regents, 3 parts, *Bound*—viz. No. 1, "Bulletins;" No. 2, "Colleges;" No. 3, "Academies."

Baltimore, Md.—Johns Hopkins University: University circulars, Vol. XI, Nos. 95 to 100.

Boston, Mass.—American Academy of Arts and Sciences: Proceedings, Vol XXVI, 1890-91.

Massachusetts Horticultural Society: Transactions, 1890, Part II; 1891, Parts I and II; 1892, Part I: Schedule of Prizes for 1892.

Marine Biological Laboratory: Annual Report, No. 4.

Boston Society of Civil Engineers: Committees Report on Weights and Measures.

Boston Society of Natural History: Proceedings, Vol. XXV.

Bridgeport, Conn—Bridgeport Scientific Society: List of Birds of Bridgeport.

Buffalo, N. Y.—Buffalo Historical Society: Annual Report, Jan. 1892.

Cambridge, Mass.—Museum of Comparative Zoology: Bulletin, Vol. XXII, Nos. 1, 2, 3, 4; Vol. XXIII, Nos. 1, 2, 3.

Harvard College: Report upon Athletics, June 1888.

Champaign, Ill.—Illinois State Laboratory of Natural History: Articles XI and XII of Vol. III: Article I of Vol. IV, and Bulletin, Vol. III.

Chicago, Ill.—Chicago Academy of Sciences: Bulletin, Vol. II, No. 1.

University of Chicago: Program of Course in Social Science, etc. "Some First Steps in Human Progress."

Chapel Hill, N. C.—Elisha Mitchell Scientific Society: Journal, Vol. VIII, Part 2.

Cincinnati, O.—Cincinnati Society of Natural History: Journal, Vol. XIV, Nos. 3, 4; Vol. XV, Nos. 1, 2.

Denver, Col.—Colorado Scientific Society: Proceedings, Vol. III, Part 3.

Des Moines, Iowa.—Iowa Academy of Sciences: Proceedings, Vol. I, Part 2.

Granville, O.—Denison University: Bulletin of Scientific Laboratory, Vol. VI, Part 2.

Indianapolis, Ind.—Geological Survey of Indiana: Annual Report, XVI, 1888; Advance Sheets of XVIII Report from S. A. Miller.

Iowa City, Iowa.—Iowa State Historical Society: Historical Record, Vol. VIII, Nos. 1, 2, 4.

Jefferson City, Mo.—Geological Survey of Missouri: "The Higginsville Sheet."

Kansas City, Mo.—Kansas City Academy of Science: "Scientist," R. M. Trouslot, editor; Vol. v, Nos. 11, 12.

Lansing, Mich.—Mich. State Agricultural College: Bulletins of Experiment Station, Nos. 80-86; 30th Report of State Board of Agriculture; "Michigan Flora" (from 30th Rep.)

Lawrence, Kan.—Kansas University: "The Quarterly, Vol. I, Nos. 1 and 2.

Little Rock, Ark.—Geological Survey of Arkansas: Annual Report for 1890, Vol. II.

Madison, Wis.—State University of Wisconsin: "Drift" in Germany—Salisbury.

State Historical Society of Wisconsin: Proceedings of 29th Annual Meeting.

Minneapolis, Minn.—Geol. and Natural History Survey of Minnesota: Annual Report XIX for 1890; Metaspermae of Minn. Valley.

University of Minnesota: Catalogue for 1891-2.

Agricultural Experiment Station: Bulletins, Nos. 19 to 23.

"A New Lemur"—Prof. Nachtrieb; From the Author.

Montgomery, Ala.—Geological Survey of Alabama: Report on Coal Measures, 1891; Report on Phosphates and Marls, 1892, Bull. No, 2; Report on Lower Gold Belt, 1892, Bull. No. 3.

Nashville, Tenn.—State Board of Health of Tennessee: Bulletin, Vol. VII, Nos. 9, 10, 12; and Vol. VIII, Nos. 1, 2, 4, 6.

Northfield, Minn.—Carleton College—Prof. Payne, Director of Observatory: Astronomy and Astro-Physics (monthly) from W. W. Payne, Editor, as issued.

New Haven, Conn.—Connecticut Geology: "Glaciers." Dana.

New York, N. Y.—New York Academy of Sciences: Annals, Vol. VI, Nos. 1, 2, 3, 4; Transactions, Vol. XI, Nos. 3, 4, 5.

New York Microscopical Society: Journal, Vol. VII, No. 1.

Linnæan Society of New York: Abstract of Proceedings to March, 1892.

American Museum of Natural History—Central Park: Bulletin, Vol. III, No. 2; Annual Report for 1891.

Torrey Botanical Club: Bulletin, Vol. XIX, Nos. 2 to 11; and Index to Vol. XVIII.

American Geographical Society: Bulletin, Vol. XXIII, No, 4, Parts 1 and 2; and Vol. XXIV, No. 4, Parts 1, 2, 3.

Philadelphia, Pa.—From Dr. A. E. Foote, 4116 Elm Avenue, Philadelphia: "Leisure Hour and Monthly Bulletin," Nos. 131 to 139.

Zoological Society of Philadelphia: Twentieth Annual Report of Directors.

Academy of Natural Sciences: Proceedings, 1891, Part III; and 1892, Part I.

Portland, Me.—Portland Society of Natural History: Portland Catalogue of Marine Plants.

Providence, R. I.—Rhode Island Historical Society: Proceedings, 1891-2.

Rochester, N. Y.—Rochester Academy of Sciences: Proceedings, Vol. I.

Salem, Mass.—Am. Assoc. for Advancement of Science: Proceedings, Vol. XL, meeting of 1891.

San Diego, Cal.—Santa Barbara Society of Natural History, (C. R. Orcutt): "West American Scientist," Vol. VIII, No. 64.

Saint Louis, Mo.—Missouri Botanical Garden: Third Annual Report.

Academy of Science of St. Louis: Transactions, Vol. V, Nos. 3 and 4; and Vol. VI, Nos. 1, 2.

Saint Paul, Minn.—Minnesota State Historical Society: Historical Collections, (Vol. VII, "Miss. River and Its Source.")

Springfield, Ill.—"Skull of Megalonyx leidyi," from the author: Description by Dr. Josua Lindahl.

Illinois State Geological Survey: Reports, Vol. VII, Vol. VIII, (small 4to Bound.)

Topeka, Kan.—Washburn College Laboratory: Bulletin, Vol. II, No. 10.

Trenton, N. J.—Geological Survey of New Jersey: "Drift or Pleistocene Formation."

Washington, D. C.—Smithsonian Institution: Annual Report, 1889; "Museums of the Future."

National Museum: Bulletins, Nos. 41, 42.

U. S. Patent Office: Official Gazette, Weekly, as issued.

U. S. Geological Survey: Bulletin, No. 82; Congrés Geologique International, List; Proces Verbeaux.

U. S. Weather Bureau: Bulletin, No. 5, "Fluctuations of Level in Ground Water."

Bureau of Ethnology: Catalogue of Prehistoric Works—Thomas; Omaha and Ponca Letters—Dorsey; Bibliography of Algonquin Language—Pilling; Contributions to American Ethnology, Vol. II, in 2 Parts; Contributions to American Ethnology, Vol. VI.

U. S. Board on Geographic Names: First Report, 1890-1; Bulletins, Nos. 1, 2, 3.

FOREIGN.

Aaran, Switz.—Aarganischen Naturforschenden Gesellschaft: Mittheilungen, VI, Heft.

Amiens, France.—Société Linneénne du Nord: Bulletin Mensuel, Année 20; Nos. 223-234.

Bonn, Prussia—Naturhistoriche Verein Pr. Rheinland: Verhandlingen, Jahrgang 8; Folge 5.

Bremen, Germany.—Naturwissenschaftlicher Verein: Abhandlungen, Band XII, Heft 2.

Brussels, Belgium.—Société Belge de Microscopie: Bulletin XVIII, Nos. 2-9 and Anales, Tome XVI.

Société Malacologique de Belgique: Proces-Verbal 1890; Tome XIX, pp. 89-116, and Tome XX, pp. 1-56.

Bergen, Norway.—Bergen Museum: Bergen Museum Aarsberetning for 1890.

Belfast, Ireland.—Natural History and Philosophical Society: Report and Proceedings for 1890-91.

***Bologna**, Italy.*—Real Accademia della Scienze, Istituto de Bologna: Memoires Accademia; Series v, Tome i.

***Beziers**, France.*—Société d' Etudes des Sciences Naturelles de Beziers: Bulletin, Vol. xiii, 1890.

***Berlin**, Prussia.*—Deutsche Verein zur Erförderung von Luftschiffahrt: Zeitschrift, Jahrgang xi, Heft 1.

Königliches (Pr.) Meterologisches Institut: Abhandlungen, Band i, Nos. 4, 5; Deutsch Meterologisches Jahrbuch, Band i, Heft 2; Ergebnisse Meterologische Beobachtungen, 1890, Heft 1.

R. Friedländer & Sohn: Naturae Novitates, 1890, Jahrg. xii, No. 23; Naturae Novitates, 1891, Jahrg. xiii, No. 23, 24, and 1892, Jahrg. xiv, Nos. 1, 11 and 17; Bericht über die Verlage, xx, No. xxi; Register Bibliographic, 1891.

***Bone**, Algiers.*—Académie d' Hippone: Compte Rendus, pp. 1-78, Bulletin No. 24; Compte Rendus Reunion ii, xvi.

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The Academy then proceeded to the election of the following officers:

President, - - -	Henry L. Osborn.
Vice-President, - -	Conway MacMillan.
Recording Secretary,	Christopher W. Hall.
Treasurer, - - -	Edward C. Gale.
Corresponding Secretary,	William H. Pratt.
Trustees for three years,	W. H. Leonard. C. W. Hall.

The persons directed at the December meeting of the Academy [see page 19] to name a Committee to take in charge the organization of a course of lectures for the Academy, named the following as such committee: W. H. Leonard, C. S. Fellows and A. H. Brackett.

Professor MacMillan read a letter which the Academy had received from Dean C. Worcester, of the Philippine Islands expedition.

Secretary Hall recommended that the letters received by the Academy from the expedition be edited and printed in the next Bulletin. The recommendation was adopted.

The following were elected members of the Academy:

W. M. Quayle, 3132 Grand avenue, Minneapolis.
L. B. Avery, the Normal School, St. Cloud.

February 6, 1893.

Seventeen persons present.

The following program was presented:

The Adaptation of structure to fossorial habit in the Pocket Gopher, *Geomys bursarius*, President Osborn.

The paper was discussed by Messrs. C. S. Fellows, J. C. Bryant and H. S. Baker.

A letter from the Philippine Islands, written by Dean C. Worcester, was read by Mr. W. H. Pratt.

The lecture course of the Academy arranged for the third Tuesday of the months February, March, April and May, was announced.

W. D. Frost was elected a member.

February 21, 1893.

Dr. W. H. Leonard in the chair.

Ninety-five persons present.

The first lecture in the special course was given this evening by Dr. Charles N. Hewitt. Subject: Cholera and Common Sense.

March 21, 1893.

Professor MacMillan presided.

Thirty persons present.

The second lecture in the special course was given this evening by Professor Henry L. Osborn. Subject: Structure and habit among the Rodents.

April 18, 1893.

A hundred or more were in attendance.

The third lecture in the special lecture course was given by Professor MacMillan. Subject: The Mechanics of Heredity.

May 2, 1893.

Twenty-three persons present.

The program was as follows:

An Apophyllite Geode; by Charles P. Berkey.

The paper gave the results of an examination of some minerals collected by C. W. Hall near Grand Marais, Minnesota.

Complete chemical analyses were made of all the minerals of this geode, and also of the diabase rock in which they were found. Grand Marais is a new locality for Apophyllite, which occurs in well formed crystals combining the prism, pyramid and pinacoid, $_{\infty}P_{\infty}$, P, oP. The diabase is very much altered and bears secondary minerals in great abundance. A chemical analysis of the diabase shows:

Silica, Si, O_2,	55.40
Alumina, $Al_2 O_3$,	22.55
Iron protoxide, $Fe O$,	3.75
Iron sesquioxide, $Fe_2 O_3$,	14.67
Lime, $Ca O$,	1.41
Magnesia, $Mg O$,	0.74
Water, H_2O,	0.97
Total,	99.49

Analyses of the different minerals:

	Apophyllite	*Laumontite*	*Chlorite*
$Si O_2$	52.61	53.87	33.14
$Al_2 O_3$	0.67	18.06	13.22
$Fe O$			12.19
$Fe_2 O_3$	trace	0.88	24.20
$Ca O$	25.22	11.19	1.50
$Mg O$	0.17	0.45	3.49
K_2O	3.03	0.29	
$Na_2 O$	1.71	0.67	
H_2O	16.17	13.18	12.34
Total	99.58	98.59	100.08

Calcite shows 99.85 per cent. $Ca CO_3$; insoluble 0.15 per cent.; $Mg CO_3$ a trace.

The analysis of the chloritic mineral is near to the composition of *Strigovite*.

The Pewabic Quartzite; by Arthur H. Elftman.

In this paper the results of a microscopic examination and field observations of a designated district in northeastern Minnesota was given. The rock to which the name Pewabic Quartzite has been given is placed by some geologists at the bottom of the Animike, by others in the lower Keweenawan. It is older than the Keweenawan because the basal gabbro of that formation cuts through and even encloses large blocks of the quartzite. The rock is not a quartzite, but essentially an aggregation of quartz, olivine, augite hornblende and magnetita. In the Birch lake region some of the so-called Pewabic Quartzite has been traced into the iron bearing member of the Animike. These results differ slightly from those of Professor W. S. Bayley, published in the 19th Annual Report of the Geological and Natural History Survey of Minnesota, pp. 193-210.

A Second Warning; Dr. Albert Schneider.

The author continued his studies on the spread of Asiatic cholera begun sometime ago. The Academy's attention had been once before called to the subject. (See Minutes for November, 1892, p. 308.)

Minneapolis, May 16, 1893.

The fourth and last lecture in the special lecture course was given by C. W. Hall.

Subject: The Formation and Deformation of Minnestoa lakes.

Thirty-eight persons were present.

June 6, 1893.

Commencement week at the University prevented attendance of many members, consequently no quorum.

September 7, 1893.

A special meeting of the Academy was held in the Public Library. President Osborn in the chair.

Eight members present.

The objects of the meeting were: 1. That the Academy be informed of the amount and condition of the material gathered by the Menage Scientific Expedition to the Philippine Islands; 2. That a statement might be made of the progress of taxidermic work on said material; 3. That the financial condition of the Academy might be stated; and 4. That such action might be taken as should be thought wise in view of the present condition of the Academy's work.

1. Secretary Hall gave a brief statement concerning the condition of the material thus far received from the Menage Expedition to the Philippine Islands and what had been done towards preparing the material for permanent preservation.

2. He then gave a summary of the taxidermic work done by Mr. James Hobson, who entered the service of the Academy in May, 1892, and closed his work in June, 1893.

3. The Secretary then stated that the immediate financial needs of the Academy for payment of transportation charges, taxidermist's wages, etc., amounted to over five hundred and fifty dollars.

4. After some discussion and a careful review of the present membership of the Academy, it was moved and carried that a soliciting committee of ten or more members be appointed to make the effort to raise the money necessary for paying the transportation charges, wages, etc., now due and if possible to carry on the work of putting the Collections into the Academy's Museum, and in short to fulfill all the obligations the Academy is under through its acceptance of the material secured by the expedition. The committee was named as follows:

Wyman Elliott, chairman, Thomas Lowry, Clinton Morrison, Chas. A. Pillsbury, C. E. Vanderburgh, R. E. Grimshaw, Verdine Truesdale, C. C. Jones, Edw. C. Gale, C. J. Bartleson, President Osborn.

After the special business of the meeting the following was ordered:

1. That a field day be observed by the Academy sometime during September by an excursion to Taylors Falls if possible. H. W. Smith and C. W. Hall were appointed a committee to do what is necessary to make a successful day.

2. It was the unanimous opinion of all present that an annual meeting be held at some date between December 20, 1893, and Jan. 10, 1894 for the presentation of a program of papers and discussions by members of the Academy and others who might be invited. President Osborn was directed to name a Committee of arrangements for such a meeting.

November 7, 1893.

Eighteen persons present.

The first paper read was by Mr. F. W. Sardeson on the "Sources of the water supply of Saint Paul."

Mr. Sardeson presented two profiles drawn through the State, one up and down the Mississippi river and the other down the Minnesota river and across to Taylors Falls. He pointed out the faulting of the Paleozoic rocks through Ramsey and Washington counties.

The second paper was on the "Resonant cavities that modify the human voice," by Dean W. X. Sudduth.

Dean Sudduth's paper aroused considerable discussion participated in by several members of the Academy.

Miscellaneous business was then in order.

Secretary Hall related what had occurred concerning the Menage Expedition to the Philippine Islands, and stated in a general way what collections had arrived from that expedition since last May, summarizing as follows: The work of the expedition in the Philippine Islands closed May 8 but just before that date, Mr. D. C. Worcester was taken ill with fever and was obliged to leave his work and Mr. Bourns started for Borneo where he was to make collections for the purpose of comparing the faunal conditions of that island with those of the Philippine Islands where work had been prosecuted for over two years. Mr. Worcester recovered sufficiently from his illness to reach California in June by the way of Japan and the Sandwich Islands at which places he made arrangements for museum exchanges. Mr Bourns on finishing work in Borneo came to America by the way of Europe. At the British Museum he arranged for exchanges for Philippine Islands material. Owing to the financial condition in Minneapolis it has been found impossible to raise the money and prosecute the work of describing new species arranging the material and making exchanges, as had been planned, with the employment of Messrs. Worcester and Bourns in Minneapolis; but it is hoped by another season this work can be prosecuted to completion.

December 26, 1893.

Postponed meeting of the Academy of Sciences.

Sixteen persons present.

The following papers were read:

Preliminary remarks on the rodent *Dipolomys ordii* by President Osborn.

To illustrate the points in the Dipolomys President Osborn exhibited a skull and a few other bones of nearly related forms; several plates were also exhibited illustrating the skeleton as a whole.

Notes on the Anorthosites of northeastern Minnesota by A. H. Elftman.

The paper reviewed the observations of Dr. A. C. Lawson upon these rocks. The anorthosites are considered to be detached blocks inclosed in the diaboses of the Lower Keweenawan. The mineral composition also varies more than geologists have generally understood.

In the discussion of the paper H. V. Winchell called attention to the fact that in the Annual Report of the Geol. and Natural History Survey of Minnesota for 1887 notice was taken of several enormous blocks of Animike strata which appeared to be pieces floating in the great Gabbro overflow surrounding them. Their position points to their being torn off at the time of eruptive activity and moved from their original site to their present situation.

Evolutionary development in some species of Brachiopoda, by F. W. Sardeson.

Mr. Sardeson's paper aroused some discussion participated in by President Osborn, U. S. Urant, C. S. Felllows and others.

The relationships and generic nomenclature of Astragalus by E. P. Sheldon.

January 2, 1894.

ANNUAL MEETING.

Fourteen persons present, with President Osborn in the Chair.

The report of the Secretary touching the scientific work of the Academy and its financial affairs was read and the latter part referred to the auditing committee.

The report of the Treasurer was read; It summarized as follows:

1893.				
Jan. 25	By Cash,	D. P. Jones, loan		$100 00
May 3	"	L. F. Menage, subscription		130 00
May 29	"	H. F. Nachtrieb, loan		20 00
June 3	"	T. B. Walker, special subscription		10 00
July 28	"	F. S. Bourns, loan		15 00
Dec. 6	"	C. A. Pillsbury, subscription		100 00
Dec. 16	"	T. B. Walker, subscription		100 00
Dec. 26	"	E. C. Gale, loan		50 00
Dec. 31	"	Annual dues collected by Prof. Hall.		212 00
Jan. 14	To Cash,	for Insurance	$ 8 00	
Jan. 6 to Nov. 13 incl.	"	to Hobson, for taxid'y	420 50	
June 6 to Dec. 26 incl.	"	for freight on Phillipine Collection	289 16	
Jan. 31 to Sept. 4 incl.	"	for drayage and misc.	5 00	
April 5	"	for engraving	7 50	
Dec. 22	"	for printing, Kimball Co.	17 50	
Jan. 3 to Dec. 28 incl.	"	for post'g, clerk hire, etc.	25 26	
Dec. 31	"	to D. P. Jones, acct. loan	25 00	
	Balance due Treasury			71 28
			$808 28	$808 28

The report of the corresponding secretary was then read. It was as follows:

NOTE.—The following is a list of publications received by the Academy for the year 1893. The list is not so large and complete as it should be, awing to the death of Mr. Pratt, and the unavoidable delay in securing a new Corresponding Secretary. Thus nearly three months receipts were accredited to the year 1894, and will appear in a future report.

CHARLES P. BERKEY,
Corresponding Secretary.

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Baltimore. Md.—Johns Hopkins University: University Circular, Nos. 103-105.

Boston, Mass.—Mass. Horticultural Society: Schedule of Prizes for 1893; Transactions, 1892, Pt. II; Transactions, 1893, Pt. I.

American Academy of Arts and Sciences: Proceedings, Vol. XXVII.

Boston Society of Natural History: Proceedings, Vol. XXVI, Pt. 1.

Brookville, Ind.—Indiana Academy of Science: Proceedings, 1891.

Buffalo, N. Y.—Buffalo Historical Society: Annual Report, 1893.

Cambridge, Mass.—Museum of Comparative Zoology: Bulletin, Vol. XXIII, Nos. 4, 5, 6; Bulletin, Vol. XXIV, Nos. 1, 2, 3, 6, 7; Bulletin, Vol. XVI, Nos. 11, 12.

Chapel Hill, N. C.—Elisha Mitchell Scientific Society: Journal, Vol. IX, Parts 1 and 2.

Chicago, Ill.—University of Chicago: The Journal of Geology, Vol. I, Nos. 1-5.

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Iowa City, Iowa.—Iowa State Historical Society: Historical Record, Vol. IX, Nos. 1 to 4.

Jefferson City, Mo.—Geological Survey of Missouri: Report, Vol. II; Report, Vol. III.

Lansing, Mich.—State Agricultural College: Bulletin, Nos. 87, 88, 90, 91, 92, 93, 94, 95.

Lawrence, Kan.—Kansas University: Kansas University Quarterly, Vol. I, Nos. 3 and 4; Kansas University Quarterly, Vol. II, Nos. 1 and 2.

Lincoln, Neb.—University of Nebraska: University Studies, Vol. I, No. 4.

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Minneapolis, Minn.—Geological and Nat. Hist. Survey of Minnesota: Bulletin, No. 7.

Nashville, Tenn.—State Board of Health: Bulletin, Vol. VIII, Nos. 5-10; Bulletin, Vol. IX, No. 2.

New Haven, Conn.—Connecticutt Academy of Arts and Sciences: Transactions, Vol. IX, Parts 1 and 2.

New York, N. Y.—Am. Geographical Society: Bulletin, Vol. XXIV, No. 4, Parts 1 and 2; Bulletin, Vol. XXV, No. 2.

New York Academy of Sciences: Transactions, Vol. XII.

Torrey Botanical Club: Bulletins, Vol. XX, Nos. 1-6 and 11.

Am. Mus. of Natural History: Bulletin, Vol. IV; Annual Report, 1892.

New York Microscopical Society: Journal, Vol. IX, Nos. 1 and 2.

American Microscopical Society: Circular.

Northfield, Minn.—Astronomy and Astro-Physics, Nos. 110 to 120; Astronomy and Astro-Physics, Nos. 107, 105.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, 1892, Parts II and III; Proceedings, 1893, Part I.

Wagner Free Institute of Science: Transactions, Vol. III, Part II.

Leisure Hours: Bulletins, Nos. 139-140.

Rochester, N. Y.—Rochester Academy of Science: Proceedings, Vol. II, Brochure 1, 2, 3.

Salem, Mass.—American Association for the Advancement of Science: Proceedings, Vol. XLI, 1892.

San Francisco, Cal.—California Academy of Sciences: Occasional Papers, No. III and IV; Proceedings, Vol. III, Part 2.

Saint Anthony Park, Minn.—Agricultural Experiment Station, Bulletin, Nos. 24 to 28.

Saint Paul, Minn.—Minn. State Historical Society; 7th Biennial Report.

Saint Louis, Mo.—St. Louis Academy of Science: Transactions, Vol. VI, Nos. 3 to 7.

Missouri Botanical Garden: 4th Annual Report.

Tacoma, Wash.—Tacoma Academy of Science: Proceedings. Mt. Tacoma.

Topeka, Kan.—Kansas State Historical Society: 4th Biennial Report, 1890-1892.

Washington, D. C.—Smithsonian Institute: (U. S. National Museum). An. Rsport, 1890; Proceedings, Vol. XIX; Bulletin, No. 40; Bulletin,—Parts A to G.

Bureau of Ethnology: An. Report, 1885-6; Contributions to Am. Ethnology, Vol. VII; Bibliography Athapascan Languages.

Department of Agriculture: Bulletin, No. 3.

U. S. Patent Office: An. Report for 1891; Official Gazette, Vol. 62, Nos. 1-12; Official Gazette, Vol. 63, Nos. 1-13; Official Gazette, Vol. 64, Nos. 1-13; Alphabetical List of Decisions, etc.; Index to Decisions.

The Weather Bureau: Bulletin, No. 6; Extract No. 11, from An. Report for 1891.

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Altenberg, Germany.—Naturforschende Gesellschaft des Osterlandes: Mittheilungen, Neue Folge, Band 5.

Amiens, France.—Société Linneenne du Nord de la France: Memoires, To. VIII: Bulletin, To. XI, Nos. 235 to 246.

Belfast, Ireland.—Natural History and Philosophical Society: Report and Proceedings, 1891-2.

Berlin, Germany.—K. (Pr.) Meteorologisches Institut: Ergebnisse, 1892 Heft II; Bericht, 1891 and 1892.

R. Friedländer Sohn: Naturae Novitates, Jahrg. XV, Nos. 1 to 13; Register Bibliographie, 1892; Bericht über die Verlage, XXI.

Beziers, France.—Société d'Etudes des Sciences Naturelles de Beziers: Bulletin, Vol. XIV.

Bombay, India.—Royal Asiatic Society (Bombay Branch): The Journal, Vol. XVIII, No. 49.

Boue, Algeria.—Academie d'Hippone: Bulletin, No. 25; Comptes Rendas, pp. 41-51.

Bremen, Germany.—Naturwissenschaftlicher Verein: Abhadlungen, Band XII, Heft 3.

Bruxelles, Belgium.—Société Belge de Microscopie: Bulletin, To. XIX, Nos. I to IX; Annales, To. XVII, Fasc. 1.

Société Malacologique de Belgique: Proces verbal, To. XXI, pp. 1-112.

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The Academy then proceeded to the election of officers. The election resulted as follows:

President, - - -	Henry L. Osborn.
Vice-President, -	W. Xavier Sudduth.
Recording Secretary,	Christopher W. Hall.
Treasurer, - - -	Edward C. Gale.
Corresponding Sec'y,	Charles P. Berkey.
Trustee to fill unexpired term of D. Percy Jones, resigned, -	Horace V. Winchell.
Trustees for three years, -	T. B. Walker. T. S. Roberts.

On Sunday evening, December 3rd, last, William H. Pratt, Corresponding Secretary of the Minnesota Academy of Natural Sciences, departed this life. Mr. Pratt was born in Bridgewater, Mass., September 6th, 1822. When a mere boy his father brought the family to Illinois, and settled in a small town, engaging in the milling business. It was in this village that young Pratt secured the rudiments of an education, and devoting his time during vacation of the village school to helping his father in the milling business. He grew to young manhood, receiving meanwhile a very fair education. Quite early he began his career as a teacher by teaching a common school. In this work he was very successful, since his tastes and talents directed him. After a few years experience in teaching, Mr. Pratt came to Davenport, Iowa, in February, 1857, where he entered into partnership with Mr. Joseph C. Lopez in the proprietorship of the Davenport Commercial College. Mr. Pratt was so successful in the management of this institution for business training that in 1859 he bought out his partner, and in the same year bought another smaller business college in the same town. Prosecuting the work until 1865, he made his school one of a chain of business colleges and subsequently sold out his entire interest to Bryant, Stratton & Merrill, the proprietors of that extensive system of commercial colleges known under the name of Bryant & Stratton. Following this sale Mr. Pratt was for many years a teacher of penmanship in the Davenport schools, but it was especially in the Davenport Academy of Sciences that he did his best work. He was one of the charter members who organized the Academy in 1867. Becoming at once its first secretary and one of its trustees, he gave to this institution the best labor and efforts of his life. During his whole connection with the Academy his work was indeed a labor of love. Mr. Pratt had also been an omniverous reader, and paying special attention to natural history, he came to the work of organizing and developing the Davenport Academy with a high degree of preparation.

A unique feature of his work in connection with the Academy was the association which he developed between the Academy and the public schools. He arranged a series of lectures to the various grades of school children in geology, zoölogy, botany and comparative anatomy. He was very competent to teach on these subjects. He effected an arrangement whereby classes came to the Academy from the various schools, listened to lectures, and examined the specimens, which were arranged for their special benefit into a series of groups or study collections. In this work Mr. Pratt continued with unabated zeal until his removal from the State, October 1890, when he came to Minneapolis with his family for permanent residence. He immediately identified himself with the Minnesota Academy of Natural Sciences, was elected in January, 1892, Corresponding Secretary of the Academy, which position he held at the time of his death. Mr. Pratt was in attendance at the meetings of the Academy whenever his health would permit, and at all times was ready to advance the interest of the meetings by contributing to discussions and papers from his own wide range of obsesvation and experience. His wide acquaintance with scientific men throughout the country and abroad formed while he was secretary and curator of the Davenport Academy proved of great value to the Minnesota Academy in his work of extending and systematizing the exchanges of the institution with kindred academies and societies.

February 6, 1894.

Ten persons present, with C. P. Berkey presiding.

The following program was presented:

Note on some water divides in northeastern Minnesota, by Ulysses Sherman Grant.

[ABSTRACT.]

The International boundary between Lake Superior and Rainy lake is often supposed to be a continuous water course, except in one place; but such, however, is not the case, as four water divides occur in this distance. The first is between Rove and Rose (Mud) lakes in Cook county. The second is the divide between North and South lakes, also in Cook county; the waters of South lake find their way into the Gulf of St. Lawrence and those of North lake into Hudson Bay. There is also a divide between Swamp (Oak) and Ottertrack lakes at the east end of Hunter's Island, the boundary stream flowing northwest from Saganaga lake through Canadian Territory; this stream finally reaches the boundary again at Lac la Croix, about fifty miles west of Saganaga lake. The distance between Swamp and Ottertrack lakes is less than one-fourth of a mile, and this alone prevents Hunter's "Island" from being an island. The fourth divide is between Lac la Croix and Loon lake, in St. Louis county.

Brulé lake, a good sized body of water in Cook county, has two distinct outlets. The water flowing from the eastern end of this lake reaches Lake Superior through the Brulé river, and that from the western

end goes through Temperance river (or perhaps through Poplar river), which empties into Lake Superior, some forty miles west of the mouth of Brulé river.

Following, Dr. Grant, Mr. Upham spoke briefly of the relative proportions of rainfall and evaporation.

[ABSTRACT.]

In that wooded Northern part of Minnesota and on its extensive prairie areas southward. A chart of the rainfall of this state, compiled by the speaker and previously referred to in the Bulletin of the Academy (Vol. III, page 151), shows an average annual supply of 32 inches of rainfall (including snow) in the region of Hunter's Island; while on the prairie part of the state it ranges from 26 inches in the vicinity of Mankato to 22 inches along our western boundary at Big Stone lake and north to Moorhead and Grand Forks. Careful records of rainfall in portions of New England, with gauging of the discharge from reservoirs, as Lake Winnipesaukee, drawn from for the water power of milling cities along the Merrimack River, shows that the evaporation from those areas of more plentiful rainfall ranges from 50 to 60 per cent. of its total amount. The proportion is probably nearly the same in the wooded country of northern Minnesota, including all the drainage areas tributary to Lake Superior and to Rainy lake and the Lake of the Woods. On the somewhat dryer prairie region the relative amount of evaporation is greater. It has been estimated to be three-fourths of the rainfall on an average for the Ohio and upper Mississippi river basins; and it may be five-sixths of the whole rainfall for the basin of the Minnesota river. The large tract of high plains, lying farther west and extending to the Rocky Mountains, has a much less rain supply, of which likewise it doubtless returns as much as five-sixths to the atmospheric circulation by evaporation.

Mr. Upham also spoke of the glacial and modified drift adjoining nearly all the lakes of northern Minnesota on some portions of their borders, so that if the drift were removed probably most of these lakes could flow away, not being enclosed by rock basins. The opinion that glacial erosion of rock-bounded depressions produced many of the lakes of drift-bearing areas, long ago advocated by Ramsay, has been recently brought again prominently to the attention of geologists by Sir Alfred Russel Wallace, writing in the Fortnightly Review (Nov. and Dec. 1893). This explanation, however, is far less frequently applicable to the lakes of the northern United States than the obstruction of drainage by irregular deposition of drift. For the great Laurentian lakes, from Superior to Ontario, Mr. Upham thinks, with Prof. J. W. Spencer, that their basins were produced by differential epeirogenic movements, resulting in warping of the earth's crust, during the Glacial period.

Secretary Hall then remarked:

[ABSTRACT.]

Sec'y Hall followed Mr. Upham with some remarks of the advisability of careful records and measurements of the determination of certain climatic conditions, particularly in temperature and rainfall between two contiguous districts of the state, viz., the area drained by the Mississippi river from Fort Snelling northward, amounting to 16,596 sq. mi. and the area drained by the Minnesota river amounting to 15,706 sq. mi. These two districts have the following points in common; first, they differ only about 900 square miles in area; second, they are uniformly level or slightly rolling in surface contour; third, they have about the same elevation above the sea, viz., 1200 or 1300 feet; They differ but little in latitude and longitude since boundary between them is an irregular northeast and southwest line. They have the following points of difference; first, the Mississippi does not shed a great deal more water per annum than does the Minnesota; second, Mississippi is largely forest covered while the Minnesota is largely one of prairie. Tongues of forest extend into the Minnesota area as patches of prairie are here and there found in the Mississippi area; third, the amount of river drainage from these two areas could easily be determined by measuring the outflow of the two streams at Fort Snelling where they unite. The temperature, the moisture of the air, the annual rainfall and other conditions can easily be determined through a series of observation stations. Some efforts were made several years ago by the speaker to secure the necessary data but they were unavoidably interrupted.

Mr. A. E. Elftman then read a paper entitled, "Notes on the geology of the Greenwood lake area."

This area is one that Mr. Elftman studied under the direction of the State Geologist of Minnesota during the field season of 1893. The paper was briefly discussed by Mr. Upham, Dr. Grant, and others.

March 13, 1894.

President Osborn in the chair.

Twenty members present.

The following papers were presented:

Differentiation of igneous magmas, U. S. Grant.

An abandoned post-glacial valley of the Saint Louis river, J. E. Spurr.

Mr. Spurr's paper was illustrated by some maps and drawings showing the position of this valley and its relation to the accumulation of glacial debris along its borders.

"Departure of the ice-sheet from the basin of Lake Superior," Warren Upham.

This was illustrated by maps and diagrams especially of the glaciation and accumulation of glacial debris in the vicinity of Duluth.

H. V. Winchell then presented the following papers:

a. "Hisingerite in northern Minnesota."

b. "Remarks on a Psuedo-Meteorite."

President Osborn then announced the gift of a collection of birds and a black walnut cabinet in which to exhibit them by R. J. Mendenhall, life member of the Academy. The Academy directed that a vote of thanks be transmitted to Mr. Mendenhall for his generous gift.

Secretary Hall then announced from the trustees the chairmen of the several sections of the Academy for the current year as follows:

Anthropology, Dr. A. E. Johnson.
Biology, Prof. L. W. Chaney.
Botany. Dr. J. H. Sandberg.
Geology, H. V. Winchell.
Invertebrate Zoology, Otto Lugger.
Mineralogy, N. H. Winchell.
Mechanical Philosophy, Herbert W. Smith.
Sanitary Science, Dr. Chas. N. Hewitt.
Vertebrate Zoölogy, H. L. Osborn.

April 3, 1894.

C. S. Fellows elected chairman. Nine persons present.

The following program was presented:

"Explanation of the so-called Pseudo-Aurora," J. P. Goode.

"Notes on several recent deep wells in Western Minnesota." C. W. Hall.

"Augite Granite of Snowbank Lake," A. H. Elftman.

"The occurrence of datolite on the north shore of Lake Superior," C. P. Berkey.

Specimens of this mineral were collected by Mr. A. H. Elftman at Flood Bay. All are of the white nodular compact variety, similar in all respects to that occurring at some of the copper mines of northern Michigan. A chemical analysis gives:

Silica, Si O_2,	36.90
Alumina and iron, $Al_2O_3+Fe_2O_3$,	1.51
Lime, Ca O,	35.67
Boric acid, $[B_2O_3]$	20.32
Water. H_2O,	5.60
Total,	100.00

B_2O_3 was estimated by difference.

Conditions are favorable for the occurrence of datolite in the rocks at several localities along the north shore of the lake, but no specimens have yet been found in place. All have been found among the pebbles of the lake shore where foreign debris is mingled with that of local derivation. It is therefore possible that the mineral belongs to the drift. All that can be said at present is that datolite occurs among the beach pebbles of the north shore of Lake Superior.

Mr. H. B. Hovland of Minneapolis, and Frank J. Harris of La Cresent, were elected members.

The announcement was made that the entire collections of the Philippine Islands Expedition, with the exception of two boxes, had reached the city and had been taken charge of for care and such taxidermic work as the Academy should direct.

April 20, 1894.

The meeting was called in response to a request for a special meeting at 8 o'clock p. m.

A large attendance of the members of the Academy and their friends came and listened to a talk by Dean C. Worcester of the late expedition to the Philippine Islands. Mr. Worcester being in the city on business connected with continuing the work on the collections, consented to relate some incidents of the life of himself and Mr. Bournes among the people of the Philippine Islands.

April 27, 1894.

A special meeting of the members of the Academy of Sciences was called for this evening. The call was made at the suggestion of the Board of Trustees and Mr. Worcester.

President Osborn in the chair. Seven persons present.

No Minutes read.

President Osborn proposed the following questions; the answers given expressed the sentiments of the members of the Academy present.

First. Is it desirable to sell part of the collections of the Philippine Islands Expedition in order to raise funds for prosecuting the work of labeling specimens and preparing manuscript for publication? The conclusion was that we cannot properly, and perhaps cannot legally, sell any part of the collections at the present stage of the proceedings towards their final public exhibition.

Second. Is it desirable to secure a lecture by Mr. Worcester? It was thought that a lecture at this season of the year could not be made to pay expenses.

Third. Is it desirable to secure a lecture by H. J. Smith on the Cliff Dwellers of the southwest? This also was felt to be inadvisable in view of the probable early exodus of our citizens to the lakes and other summer resorts.

A Committee was then appointed to secure subscriptions from members and friends of the Academy for the purpose of securing Messrs. Worcester and Bourns to work up the Philippine Islands collections, giving the specimens labels and leaving them in shape further preservation; and further to write the necessary manuscripts, describing new species and relating the general scientific results of the Expedition for publication by the Academy.

The Committee appointed was as follows: President Osborn, E. T. Allen, C. J. Bartleson, Chas. S. Fellows, E. C. Gale, C. W. Hall, Dr. W. H. Leonard, H. F. Nachtrieb, Dr. T. S. Roberts, T. B. Walker and H. V. Winchell.

It was further ordered that Professors Osborn and Nachtrieb and Dr. Roberts constitute a committee to arrange an outline list of the contents of the Philippine Islands collections for publication and to prepare a statement of the present needs of the Academy for the editorial pages of the city papers and to secure the coöperation of such papers in presenting to the public the present situation.

J. E. Spurr, of Massachusetts, was elected a member.

May 8, 1894.

President Osborn in the chair.

Twenty-one members present.

The following program was presented:

"Notes on hermaphroditism in the frog," Professor H. F. Nachtrieb.

The paper was discussed by President Osborn, C. S. Fellows, Professor MacMillan and E. C. Gale.

"Experimental embryology of plants, Professor MacMillan.

Mr. Elftman proposed the name of F. E. Harmon for membership. Mr. Harmon was elected.

June 11, 1894.

C. S. Fellows chosen chairman pro tem.

Sixteen persons present.

The following papers were presented:

A review of some recent theories of heredity, Professor L. W. Chaney, Jr.

Classification of the Brachiopoda, F. W. Sardeson.

Recent essays toward a classification of the Keweenawan Series in northeastern Minnesota, A. H. Elftman.

A communication was received by the Academy from the Council of the Scientific Alliance of New York signed by N. G. Britton, Secretary, in which attention was called to a series of preambles and resolutions adopted by the Alliance April 28, 1894, touching a reduction of postage rates on natural history specimens.

After listening to the communication, A. H. Elftman introduced the following memorandum which was offered to be sent as a letter of the Academy signed by the Secretary to the Senators and Representatives in Congress from the State of Minnesota.

SIR: I am directed respectfully to call your attention to the following preamble and resolutions recently adopted by *The Minnesota Academy of Natural Sciences* and earnestly to solicit your cooperation in the endeavor to obtain a reduction of postage rates on natural history specimens.

WHEREAS, The transmission by mail of specimens of natural history between students and workers in science has long been a very important means of facilitating their labors, and thus of diffusing knowledge and advancing the interests of science; and

WHEREAS, Such transportation is greatly hampered and restricted by the high rates of postage recently demanded for such material in both domestic and foreign mails; and

WHEREAS, The lack of provision for low postage rates upon such specimens amounts to a restrictive and often prohibitive tax upon the dissemination of knowiedge; therefore,

Resolved, That *The Minnesota Academy of Natural Sciences* do hereby memorialize the Senators and Representatives of Minnesota in behalf of a reduction of postage upon scientific specimens, and to use their influence in every practicable way to further this object, so important to the interests of scientific study and research throughout the world.

October 2, 1894.

Vice President Sudduth in the chair.

Eleven persons present.

On motion the following program prepared for this meeting was postponed until some future date:

1. Physical features of the region around Lake of the Woods, Professor MacMillan.
2. The Succession of Paleozoic formations in southeastern Minnesota.

November 13, 1894.

Vice President Sudduth presided.

Thirty-one persons present.

The subject for the evening was a paper by Dr. Chas. N. Hewitt, chairman of the section of Sanitary Science, "A city water supply from the viewpoint of a health officer."

After the paper read by Dr. Hewitt, an explanation of several statistical charts prepared for the occasion was given; the subject was further discussed by E. S. Kelley, Health officer of the city, N. H. Winchell, Geo. C. Andrews, Dean Sudduth and others.

A record of the weather of Minneapolis has been prepared for the Academy's *Bulletin* and it will appear in the following pages. Mr. William Cheney for many years a voluntary observer and correspondent of the U. S. Signal Service compiled the record [See Paper H]

There is also an abstract of the correspondence of Messrs. Bourns and Woacester edited to form a sort of itinerary of the Menage Scientific Expedition to the Philippine Islands. This forms Paper I.

[*Paper A.*]

THE RODENTIA IN EVOLUTION—A PRELIMINARY STUDY.

WITH PLATE I.

H. L. Osborn.

It is the great objection constantly brought against evolution by those who have not accepted the doctrine, that no cases of evolutions now in process can be produced. Such objectors claim with reason that evolution, if it be true, must be universal, not only in range of application, but in time, and hence should be observable in animals and plants of to-day. It may be properly noted that biology is a young science, and that very accurate observations would be required to show that evolutions at the present time are not taking place as well as to show the converse. In view of the great variability of animals and plants, it seems almost strange that anyone should suspect that fixity in animal form is a law of life, and yet in spite of the variability in individuals, the lines of specific form run remarkably true, many species being almost or quite unchanged, as can be shown by sundry data, for many thousand years, and the recognition of this fact has helped the native conservatism of the human mind to hold to the position of immutability of animal species with wonderful tenacity. The reason for this is found in the fact that the observations on which the proof of evolution rests are more unusual, hence while students almost universally accept the theory as a working hypothesis, it only slowly gets abroad among the notions of mankind.

If any great group of animals be examined at all thoroughly their relations are unintelligible, except on the evolution hypothesis. It was the suggestion of Professor Louis Agassiz, the great opponent of Darwin, that the likeness of animals and their dissimilarities were indications of an ideal or mental connection between them due to their production by the same maker, just as the similiarities in style of works of art owe their existence to unity, not in the objects, but in the producer. It is necessary on this theory to believe that each kind of animal was produced in the first instance with special reference to the station it now inhabits, and all its structure must show evident reference to that specific end, and no other. It is late in the day to be proving evolution to the professional zoölogist, but as these pages are intended partly for the laity, these commonplaces may, I trust, be pardoned. The consideration of any group of animals shows that while Agassiz's theory of the cause of classification is ingenious, it is also highly improbable, because many facts go to show that animals judged by the standard of structure are but poorly designed to occupy the situation they occupy if they were originally designed to be such animals as they are to-day. The doctrine of descent with modification, would, however, as noted at the outset, require evolution to be now in process, and creatures whose structure is not as well adapted to theie surroundings as others must be regarded as forms lately come with new surroundings and not yet fully evolved.

The rodents are a large order of mammals. There are over 900 species enumerated. They are the most widely distributed of any order of the class. They present a great variety of situation and habit, and therefore they are a very favorable group on which to study the problems of evolution. At the risk of being tedious, I will briefly sketch the order, for some notion of the order is indispensable for my present purpose. There are four general kinds or sub-orders of *Rodentia*, viz.: The squirrel kind or *Sciuromorpha*, the porcupine kind or *Histricomorpha*, the mouse kind or *Myomorpha*, and the rabbit kind or *Lagomorpha*. These sub-orders are not in the least distinguishable on physiological grounds. The lines of habit and situation cross and recross the lines of structure and model in the most persistent way, but they are clearly definable in anatomical terms, as are also all of their subdivisions. Some of the anatomical terms of their definition will be given with the account of each sub-order.

The Sciuromorpha have a skull broad in frontal and parietal regions (cf. fig. 5, the ground squirrel, Tamias), a molar bone which reaches up behind the maxillary to the usually free lachrymal, usually five molar teeth, usually only three sacral vertebrae with the pelvic not very firmly articulated, the pubic symphsis is generally long and strong, the fibula is free from the tibia (cf. fig. 8 of prairie dog). The Sciuromorpha include animals of almost every habit and station, mostly inhabitants of the north temperate zone. They are the ground squirrels and spermophiles, prairie dog, marmot and rare and little known sewellel, all terrestrial and partly fossorial, and the beaver, fossorial and aquatic, the tree squirrels and arboreal and the flying squirrel and anomalure of Africa, arboreal and partly aerial. These are the simplest *Rodentia* in most respects, and the peculiarities of the others, except the Lagomorpha, can readily be understood if we suppose they are descended from these. They are all much alike osteologically, the beaver being the only one at all widely divergent, as can be seen in the case of the ground squirrel, the flying squirrel, and the beaver by a comparison of figures 2, 4 and 5.

The *Hystricomorpha* or porcupine kind are almost strictly confined to South America, the chief exception being the true porcupine of Europe, which furnished a figure for Shakespeare in Hamlet. The most of the family are not spiny, nor do they correspond with the correct notion of a porcupine, but they present structural features which distinguish the sub-order. The skull is broad in the frontal and parietal region, but the molar bone is short and does not run up to join the lachrymal, the zygomatic arch is short and the infraorbital foramen is very large (as in the beaver only among Sciuromorphs). The molars are never five in number and are in many less than four, in some three or even only two. There are usually four sacral vertebræ and sometimes (Paca) five. The number of toes is rarely five and sometimes only three and the metatarsals are never fused. The tibia or fibula are always distinct. These characters are easily derivable from the Sciuromorph type—the reduction of number of teeth, the incorporation of more bones in the sacrum and the reduction in the number of toes are all quite easily possible from Tamias as a starting point. The various creatures of the suborder are but little known except to travelers or special students. Some of them are the *Dega* of Chili of the size and habits of a rat; the plate beaver of Brazil, semi aquatic, with cylindrical scaly tail but soft wooly hair; the porcupines arboreal often prehensile tailed creatures; the chinchilla a terrestrial and fossorial creature of Chili and Peru; the *vischaca* of Argentine Republic burrowing so extensively as to make the ground unsafe for man or beast; the paca and capybara, the latter as large as a Newfoundland dog and weighing 100 pounds, a terrestrial animal but perfectly at home in the water; the Pategonian "guinea pig" or cavy a terrestrial and fossorial animal.

The *Myomorpha* or mouse-kind is the largest suborder of Rodentia and the most universally distributed being absolutely cosmopolitan. Their osteological characters are, a narrow frontal and parietal region (cf. fig. 3), slender zygomatic arch, malar bone slender and very short (fallen out in specimen figured) molars never 5 usually 4 often 3 or even 2, generally 4 and sometimes 5 sacral vertebrae, in some no pulie symphisis (cf. fig. 9 *Geomys* or pocket gopher.) The fibula is always anchylosed to the tibia and the toes are 4 or 3, in some the molars are found to found to form a canon bone. A few among the many mice are mentioned to convey an idea of the great range of habit within the limits of this exceedingly clearly defined sub order. 1, The water rat, *Hydromys* is nearly perfectly aquatic, with close glossy fur, flat head, slender body, a long tail, partially webbed feet, a native of Van Diemensland. 2, *Gerbilles* of which 50 species are said to be known is a leaping rodent with elongate leg and tail. 3, The Hamster mouse is a burrowing rodent with large cheek pouches as in the very different pocket gopher, tail very short but eyes large (unusual in fossorial animals) and toes short clawed. 4, The house mouse also *Acomys*, a mouse with spines in the skin recalling the porcupine belongs here. 5, The field mouse is a burrowing or running rodent, closely allied to it are the arctic *Cuniculus* and lemming and the muskrat an aquatic mammal with slightly webbed feet and horizontal flattened scaly tail. 6, The pouched gophers are considered a separate family of myomorphs but they are very like, in many respects, the field mice from which they seem to have been descended. They are chiefly fossorial, have minute eyes, short tail, a very remarkable sacrum and pelvis which has no pubic symphesis. 7, Still more extremely fossorial are the rodent moles, *Siphneae*, which are perfectly subterranean, have no functional eyes, no external ear and limbs short, stout and mole like. 8, The Jerboa or jumping mouse, or kangaroo-rat is a slender mouse like rodent with long slender hind limbs and reduced fore limbs, anterior part of body the cervical vertebræ being anchylosed, hind foot of only 3 toes and the metatarses are fused. The mice present the appearance of a very productive race of beings forced by pressure of numbers and competition in various forms to push out from terrestrial habits to fossorial, aquatic and other ones and as if they had some of them been thus changed in habit much longer than others, some being more competely correlated in their structure by their peculiar habits than are others.

The fourth suborder or *Lagomorpha* is very small and contains only two genera, *Lagomys* and *Lepus*. These unite in certain osteological characters unique among rodents, especially:—2 incisons on each side of the upper jaw (one rudimentary.) This is a more simple condition than that of remaining rodents and more nearly ancestral, reduction in the number of the teeth being among the results of specialization in many cases (eg Ruminants Cetaceans, etc., and also in the more specialized rodents.) The fibula, however, is not distinct but is perfectly fused with the tibia, more completely than in any Myomorph so that in this respect the Lagomorphs are more specialized than the Sciuromorphs. The Pika and hares, burrowing terrestrial and leaping in habit make up the suborder.

It will appear from this summary that the rodents cannot be classed by similarity of habit because if we were to attempt to place together all the aquatic kind we should have as a result a motley assembly of Sciuro, Historico and Myomorphs alike only in a few superficial features but fundamentally wholly diverse. So too, if we should attempt to put together all the fossorial rodents we should be obliged to associate marmots, chinchilla and mice, separating these essentially unlike creatures from arboreal terrestrial and aquatic animals, totally different in habit which are in many cases almost absolutely identical in bodily structure. Such a procedure is intolerable to the scientist of today. It was natural enough to the infantile scientist at the dawn of science to call all aquatic animals fish, and the names starfish, etc., are survivals of this ancient tendency. But science long since abandoded such crudities and habit and station are inevitably regarded as the latest acquisitions of animals to be followed later if it have any further history by structural adaptations to fit.

Before passing to the fuller development of this last point, I wish to dwell for a moment upon a detailed comparison of the muskrat and the beaver, two aquatic rodents. The dorsal surfaces of the skulls of these are represented in figures 1 and 2. These, on examination, are not found to present anything in common beyond the mammalian and rodent construction found in all the class and order. In one the narrow frontal and parietal, in the other these bones are broad; in one the very short molar, in the other a long and stout one reaching from the squamosal to the lachrymal bones. In the bones of the hind leg we find the anchylosed fibula of the muskrat, the free fibula of the beaver, but we do find in each a strong ridge on the hinder side of the tibia (as also in many other rodents). On the other hand if these be compared with animals of very unlike habits we shall find many points of resemblance. The beaver and the ground squirrel can be compared, figs. 2 and 5, and the muskrat and the brown rat, figs. 1 and 3, and important similarities at once come to light. Upon Professor Agassiz's view this would mean that when aquatic animals were being produced several plans used also in producing terrestrial and fossorial animals were adapted to the purpose in spite of the fact that one must have been more suitable than others and that perhaps some wholly non-rodent plan would have been more suitable still. Webbed feet are better for swimming than those that are not webbed; the beaver has good webbed feet and the muskrat has feet that are hardly webbed at all. It is quite obvious that the implications of the multitudes of such facts as these would be if they referred to the work of an artisan, that many poor models and few good ones were available when he was at work making his productions.

If, however, the animals of today be regarded in the light of evolution, all these matters at once become clear. Fossorial animals, for instance, vary greatly in the degree to which they are specialized for burrowing. Some are burrowers in habit, but hardly, if at all, in structure. Others have external but not the more deeply seated specialization of structure, while still others are completely fossorial in structure as well as habit. The fossorial habit in its external form, as in the moles, is marked by the following features, short hair, no external ear, eyes abortive and subdermal, anterior part of body stronger than posterior fore limbs short, stout hand, broad stout nails long, tail short or wanting, the sacrum stoutly anchylosed to the pelvic bones. Many of these characters are obviously favorable to a fossorial animal. They are possessed *in toto* by some rodents, as for instance, the male Bathyergus, and in part by others, as, for instance, the pocket gopher, but they are hardly possessed by the striped gophers, *Spermophilus 13—lineatus*, hardly differs in any respect from the ground and tree squirrel, though Franklyns gopher, *Spermophilus franklyni*, does present enlarged nail on the fingers and somewhat stouter limb bones than the striped gopher. And these facts would seem to mean that evolution has taken place, and in some gone further in production of variety of structure than in others, that some are more completely specialized, while others are now in the act of specializing, and others hardly begun.

Almost all the rodents in the species, genera and families, can be arranged in series, which lead from less specialized centre on more and more specialized radii to highly specialized final terms. The ground squirrel, the tree squirrel, the flying squirrel, and the anomalure, form such a series, starting from a point the ground squirrel, from which also we can proceed toward the spermophile, the marmot, the prairie dog, and finally the sewelled. The ground squirrel or some similar form is also a possible starting point toward similar centres in the hystricomorpha and myomorpha, but here the immediate terms are not yet known; perhaps they are wholly lost and will never be known; but it is not wholly certain that they may not some day be found, or their remains be found, if they existed and are now extinct.

It is not possible in the limits of this paper to refer to many other cases similar to the fossorial. The case of the development of the leaping habit has already been presented before this Academy. A very large amount of study of the rodents from this standpoint is necessary before the question can be thoroughly examined. Only one more point in conclusion. My attention was directed to this whole subject several years ago during the agitation which was then so very lively between the New Lamarkian and the Post Darwinian schools of evolution. Professor Cope, the leading exponent of the former, seeking a cause of the appearance of favorable variation which could be seized upon by natural selection and become adaptive modifications of structure, announced it as his belief from the study chiefly of vertebrate osteology, that the uses of the organs were productive of adaptive shapes and construction, so that as a result of change of habit a creature, though by inheritance from its parents it would have the family likeness, would also have a certain unlikeness, leading toward a perfect fitness for a new habit. This change, he argued, would be seized by inheritance and reappear in the next generation, when it would be improved upon, and so on, extending to the organization more and more deeply till a new organization would result. It would be necessary to such a mechanism of evolution that variations due to use should be shown to be transmissible by inheritance. The Post-Darwinians, represented by Professor Lankester, among the English, claim that inheritance does not extend to these acquired variations, but that variations which appear at birth in the animal are inheritable. When the extreme isolated cases are searched over, an abundance of examples can be produced which seem to substantiate Cope's position, but when the data are all carefully surveyed, the discovery of animals with special habits, but not correlated structure, are not easily explained. They seem to be creatures waiting for evolution to come to their aid, and by giving them specialized structures to help them in the struggle for life. If use develops function, animals as habitually fossorial as the striped gopher ought, it would seem, to be so in structure far more completely than they are. So the muskrat ought to have a more perfectly webbed foot, and so on. The Neolamarkians always answer such objections by the assumption that time has not yet elapsed for the changes to be brought about. But to me the detailed study of the rodents does not appear to favor Neolamarkism. Though it so plainly indicates that evolution has taken place, it also plainly indicates that structure is extremely conservative, and does not readily lend itself to change. We do not yet know how long the rodents have been as they are to-day, but the main line of descent had diverged by Tertiary time. So far as data are at hand from which to calculate the rate of evolution, the rate seems slower than it ought to be if the results of the uses of organs are seized directly by evolution.

February 2, 1892.

[*Paper B.*]

NOTES ON THE MINNESOTA SPECIES OF LACINIARIA.

E. P. Sheldon.

The genus *Laciniaria* is used to designate certain perennial North American herbs belonging to the natural order Compositæ. So far as has been determined this genus has fifteen living species and attains its greatest predominance in the South Atlantic states.

Speaking somewhat more minutely, they are characterized as follows: Perennial herbs with simple, wand-shaped, very leafy stems, from a tuberous or corm-like root-stock; they bear reversely racemose or spicate heads of handsome rose-purple flowers in late summer or autumn; the leaves are all alternate, entire, rigid and mostly glabrous.

The species usually inhabit dry, open, uncultivated grounds, although certain of them seem to prefer moist, low grounds or wet edges of pine barrens. Most noticeable in this regard are *L. spicata* (L) O. K., and the peculiar bog-inhabiting forms of *L. scariosa* (L.) Hill.

In general it may be said that *Laciniaria* is found from Ontario and the Saskatchewan on the north to Florida and northern Mexico on the south, and from the Atlantic ocean on the east to the Rocky mountains on the west.

Laciniaria scariosa (L.) Hill is by far the more common species, as it is found throughout the range; and considering its extreme variability and its close relationship to a large number of the other species, it may be taken as a centre around which the rest may be grouped.

In genetic relationship *Laciniaria* is near to *Brickellia* and *Kuhnia*, on the one hand, and *Garberia* and *Carphephorus*, on the other.

It is to be noted that these all belong to the section

Adenostylinæ of the tribe Eupatoriaceæ. A tribe which has but one genus on the European continent, and that they are all typical North American prairie composites which attain their greatest abundance in the southern portion of their range.

Points like these tend more than anything else to throw light on the origin of the American composites and help to explain their present distribution over the North American continent.

We often turn aside from the more far-reaching points of relationship and distribution when studying a group of plants and question their utility.

In the present case a most pleasing answer can be given. First of all their beauty attracts our attention, and to such a degree that many species are artificially grown both in America and in the botanic gardens of the continent. Then again the corm or rootstock, particularly that of *Laciniaria scariosa* (L.) Hill, is largely used in medicine and as a substitute for vanilla.

SYNOPSIS OF MINNESOTA SPECIES.

§1. Pappns very plumose; heads 16-20 flowered, cylindraceous with turbinate base; bracts of the involucre much imbricated with herbaceous tips if any; lobes of the corolla pilose inside; leaves all linear and rigid, the lower elongated and grammiform.

1. *L. squarrosa* (L.) Hill.—Pubescent or partly glabrous; stem stout, 6 to 20 inches high; heads few or sometimes numerous in a leafy spike or raceme; bracts of the involucre all herbaceous, lanceolate, rigid and with somewhat pungent tips, squarrose-spreading and prolonged. Dry gravelly or sandy soil, Ontario to Minnesota, Nebraska, Texas and Florida.

In the southern portion of the state, rare.

2. *L. cylindracea* (Michx.) O. K.—Most glabrous, a foot high; heads few or several, 16-20-flowered, an inch or less long; bracts of the involucre all appressed, barely herbaceous, rounded and abruptly mucronate at the tip, the outermost very short. Dry prairies and woodlands, Ontario and Michigan to Minnesota and Missouri.

Frequent in the central portion of the state, but rare north and south.

Specimens from Brainerd (Macmln & Sheld.), Goodhue county (Sandberg), Minneapolis (Herrick), Glenwood (Taylor).

L. cylindracea (Michx.) O. K.—Var. *solitaria* Macmln.* Differs fron the type of the species in having a bushy stem 6 to 12 inches high, heads somewhat larger, never spiked, but solitary, terminal, erect or nodding.

This variety has much more the aspect of a pink than a Blazing Star.

Specimens from Brainerd (Macmln & Sheld.), Glenwood (Taylor).

§2. Pappus minutely plumose; heads 3 to 6-flowered; bracts of the involucre acuminate or mucronate, coriaceo-herbaceous, not appendaged; corolla-lobes naked; leaves all narrowly linear and the upper generally acerose.

3. *L. punctata* (Hook.) O. K.—Stems erect, 6 to 30 inches high, from a thick and branching or sometimes globular rootstock; leaves and bracts punctate, rigid; head 4 to 6-flowered, oblong or cylindraceous, from one-half to three-fourths inch long. Mostly numerous and crowded in a dense, often leafy, spike; bracts oblong, abruptly cuspidate—acuminate, often languinous ciliate. Dry prairies and plains. Saskatchewan and Minnesota, west to Montana and Colorado, south to Texas and New Mexico. Common in the prairie region of the state, more rare eastward.

Specimens from Red Wing, Cannon Falls (Sandberg), Blue Earth county (Leiberg), Cedar Lake (Holtz), Montevideo (Moyer), Lake Benton, Minneapolis (Sheldon), Emmet county, Iowa (Cratty), Lindbourg, Kansas (Bodin).

FORMS.

A. *albiflora* n. f.—Six inches to a foot high, spike short, heads 4 to 6, 2 to 6-flowered, bracts abruptly acuminate.

High crests of the Cotean des Prairies, Lincoln county.

B. *corymbosa* n. f.—Heads 1 to 3, borne on the ends of leafy ascending branches, 3 to 5 inches in length, tips of the involucre gradually acuminate, spreading.

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* Bot. Gaz. Jan. 1891.

High crests of the Coteau des Prairies, Lincoln county.

§ 3. Pappus from barbellulate to minutely short plumose under a lense, not to the naked eye.

* Heads subglobose or hemispherical, 15 to 40-flowered; involucral bracts many-ranked, somewhat spreading; corolla lobes short.

L. scariosa (L.) Hill.—Pubescent or glabrate; stem stout, 1 to 5 feeet high; lower leaves spatulate or oblong-lanceolate and tapering to a petiole, uppermost small, linear; heads racemose or spicate, the few to numerous involucral bracts broadest and rounded at the summit, either herbaceous or scarious edged and tipped with purple, greatly variable. Dry and sandy ground, Ontario and New England to the Saskatchewan, west to the Rocky mountains and south to Florida and Mexico.

Common in the southern and central portions of the state.

Specimens from Glenwood, Alexandria (Taylor), Blue Earth county (Leiberg), Minneapolis (Herrick), Brainerd (Macmln & Sheld.), Idlewild, Lincoln county (Wickersheim), Montevideo (Moyer), Minneapolis (Oestlund), (Kassube), Goodhue county (Sandberg), Minneapolis, Lake Benton, Sleepy Eye, Springfield. (Sheld.)

L. scariosa (L.) Hill. Var. *corymbulosa* Sheld.*—Tall and stout, smooth throughout, except the minutely roughened inflorescence; bearing the single *heads at the end of leafy ascending branches* which are 2 to 6 inches long; heads longer than in the type; scales of the involucre broadly obovate, dark purple, slightly scarious or not at all.

This plant was first found by Mr. John B. Leiberg in a bog near Mankato.†

Recent search has found it to be the prevailing form in bogs and low grounds throughout the southern and western portions of the state.

Specimens have been examined from Blue Earth county (Leiberg), Verdi, Lake Benton, Sleepy Eye, Waseca, Princeton, Fergus Falls, Minneapolis (Sheldon), Nicollet county

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* Bull. Geol. Nat. Hist. Surv. Minn., 9, 77, 1894.

† Upham, Cat. Flora, Minnesota, p. 69, 1883.

(Ballard), Meeker and Kandiyoh counties (Frost), Pope county (Taylor).

FORMS.

(A). *solitaria*, n. f.—Stems slender, 10 to 18 inches nigh; lower leaves linear-spatulate, gradually becoming smaller as they approach the small subglobose solitary head. Dry ground, rare. Cedar Lake (Holtz).

(B). *globosa*, n. f.—Strict and stout, 6 to 18 inches high from a branching rootstock, heads globose, sessile, bracts spatulate with scarious *white margined* tips. Flowers from *rose purple* to *cream-colored.*

Crest of the Coteau des Prairies at Verdi, Lincoln county, Minn.

** Heads oblong, 5-flowered; involucre squarrose by the spreading of the colored tips.

L. pycnostachya (Michx.) O. K. Hirsute or glabrous below; stem stout, 3 to 5 feet high, leaves crowded throughout, the lower lanceolate and the upper very narrowly linear; spike dense, cylindrical (5 to 10 inches long), heads (4 to 6 lines long), all sessile; bracts of the involucre 14 to 16, oblong or the inner narrower; the more or less scarious tipt purple, usually acute. Prairies, Indiana to Minnesota, south to Arkansas and Texas.

Frequent through the southern portion of the state.

Specimens from Minnesota Lake, Glenwood (Taylor), Springfield, Waseca (Sheldon), Montevideo (Moyer), Minneapolis (Oestlund).

*** Heads from short-oblong to cylindraceous; bracts of the involucre all appressed, obtuse.

L. spicata (L.) O. K.—Glabrous, or somewhat hairy; stem tall and stout, 2 to 5 feet high, very leafy; heads 8 to 13-flowered, one-half inch long, almost erect. Closely sessile and numerous in a dense spike 4 to 12 inches in length. Moist grounds from Massachusetts to Minnesota, and south to Florida and Louisiana.

South half of the state, rare.

Specimens from Blue Earth county (Leiberg), Red Wing, Cannon Falls (Sandberg), Minneapolis (Kassube), Lake Benton, Verdi, Lincoln county, Sleepy Eye.

March 8, 1892.

[*Paper C.*]

NOTES ON THE ALPINE CHARACTERISTICS OF THE MINNESOTA CREST FLORA OF THE COTEAU DES PRAIRIES.

E. P. Sheldon.

In Minnesota the rolling series of prairie hills known as the Coteau des Prairies, reaches its greatest heights in Lyon, Lincoln and Pipestone counties.

It is to be noted that nowhere in the state, except in the iron ranges on the north, do we attain so high an altitude as when we travel over the exposed treeless bluffs which constitute the crest of the Coteau.

Lake Benton which is the highest above the level of the sea of any of the Minnesota lakes, occupies a long narrow depression in the Coteau, presumably a part of the bed of an ancient watercourse. Arriving at the town of Lake Benton during the month of August, 1891, I was particularly struck by the characteristics of the flora.

In general we find many of the typical praire plants of the southern part of the state. But there are also species from the Saskatchewan district and the Rocky mountains, which find on these high and dry bluffs something remarkably approaching their natnral habitat.

It is to the prevalence of these, and to the peculiarly dwarfed habits of growth of the general flora that I wish to direct particular attention.

The phrase "Alpine characteristics," as applied to a part of this flora, should not be misunderstood. It is not that we have here a large number of peculiarly mountain plants, but rather that in their dwarfed habits of growth, nearly every species observed resembles the stunted and stubby growth so familiar to everyone who has traveled over bare mountain heights. I have noted that these hills are well nigh treeless, but in the gulches and waterways down their sides, stunted growths of *Quercus tinctoria* Bartr. are frequently found. *Quercus macrocarpa* Mich. is more rare, and I have frequently gone miles without seeing a single specimen.

Amelanchier canadensis Torr. and Gray is occasionally met with, as also *Salix longifolia* Muhl. and *Populus tremuloides* Michx.

The above which we know ordinarily attain to a considerable height, here present a bushy, shrubby appearance, and are commonly to be found flowering and fruiting at from one-fourth to one-third their normal height.

Many of the prairie pulses were noted: *Psoralea esculenta* Pursh., a characteristic plant of the Cotea, was, at the time of my visit, just breaking loose from its summer moorings and preparing to scatter its seeds according to the custom of tumbleweeds. Its near relation, *Psoralea argophylla* Pursh., was frequently found at from five to eight inches in height. The Astragali come in for their due share of consideration.

Astragalus crassicarpus Nutt. was of course plentiful, but with peculiarly dwarfed and densely hirsute leaves.

Astragalus laxmanni Jacq. is quite common at from 3 to 4 inches high.

Astragalus hypoglottis L. and *Astragalus lotitlorus* Hook. are more rare plants of these prairie slopes.

Nearly related to the above is *Spissia lamberti* (Pursh.) O. K., which is often abundant and covered with a plentiful growth of *Erysiphe*.

Very peculiar are the forms of *Petalostemon violaceus* Michx. and *Petalostemon candidus* Michx. Low, dwarfed, and often bushy, their crowded, subglobose heads have more the appearance of a pink or a bachelor's button escaped from our gardens.

Many other pulses were found, and as respecting their habits of growth, I must particularly mention two more. *Glycyrrhiza lepidota* Nutt. is found growing abundantly on the crest in low depressions and scatters its cockle-like burs through the agency of every passerby. *Parosela daleai* (L.) Britt. crowds out almost every other plant in many places on the sandy shores of lake Benton, where it is found fruiting at from two to twelve inches high.

Traveling up the "Hole in the Mountain" one early morning I met my first specimens of *Pentstemon acuminatus* Dougl. This plant prefers lower and somewhat moister ground than the other prairie species of Pentstemon. Besides this, *Pentstemon albidus* Nutt. and *Pentstemon hirsutus* (L.) Willd. were noticeable for their stunted preference of high morainish ground.

Many composites are, of course, to be included in this category. The peculiar forms of the different species of *Laciniaria* have been mentioned in a preceding paper.* *Solidago nemoralis* Ait. and *S. mollis* Bartl. were found flowering at from three to ten inches. The latter with its upright, rigid *hoary-pubescent* leaves, and its strict, dense thyrse is especially noteworthy. *Kuhnia cupatorioides* L. growing in bunches; stout and somewhat approaching the var. *corymbulosa* Torr. and Gray is very abundant; as also the purple cone flower *Brauneria pallida* (Nutt.) Britt. with its club-shaped stems. The latter was found completely matured and only six or eight inches high.

Gaura coccinea Nutt. was rarely found with branching, somewhat cæspitose habit. Two mustards attracted my attracted my attention. *Erysimum asperum* DC., which often flowers at from five to six inches on the high shores of Lake Benton; and *Sisymbrium incisum* Englm., found in the shade of dwarfed oaks.

The appearance of the latter is quite remarkable in Minnesota, although there is no reason why we should not expect to find other Rocky-mountain mustards on these paririe heights.

Plantago purshii R. & S. has frequently been observed flowering at from three-fourths to one inch high, both on the crest and at Pipestone quarries twelve miles away.

Many grasses came to my notice. *Boutelona racemosa* Lag. and *Boutelona hirsuta* Lag. were found to range from three to seven inches in height at the time of flowering.

Aristida purpurea Nutt., with its long triple awned seeds, looking more like a bunch of miniature pitch-forks than anything I can conceive, was abundant, as also *Stipa spartea* Trin., with its droll habit of having its seeds bore their way down into the soil.

Sporobolus depauperatus Vasey and *Andropogon sco-*

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*See these Bulletins, vol. III, No. 3.

parius Michx. are two other grasses which show very depauperate forms.

Among the many other plants which may be mentioned as showing Alpine characteristics on this crest of the prairie hills are the following:

Festuca ovina L.; *Festuca nutans* Willd; *Amorpha canescens* Nutt.; *Amorpha microphylla* Pursh.; *Prunus pumila* L.; *Teucrium canadense* L.; *Lithospermum angustifolium* Michx.; *Senecio lugens* Richard; *Crepis runcinata* Torr. & Gray; *Zygadenus elegans* Pursh.; *Hedeoma hispida* Pursh.; *Lepachys columnaris* Torr. & Gray; *Cyperus aristatus* Rottb.; *Chrysopsis villosa* Nutt.; *Linum rigidum* Pursh.; *Castilleia sessiliflora* Pursh.; *Solidago lanceolata* L.; *Solidago rigida* L.; *Aster ptarmicoides* Torr. & Gray; *Aster sericeus* Vent.; *Aster oblongifolius* Nutt.; *Allium stellatum* Nutt.; *Acerates viridiflora* Ell.; *Helianthus lætiflorus* Pers.; *Helianthus hirsutus* Raf.; *Artemisia frigida* Willd; *Geum triflorum* Pursh.; *Delphinium azureum* Michx.; *Physostegia virginiana* Benth.; *Rudbeckia hirta* L.; *Oxybaphus hirsutus* Sweet; *Scutellaria parvula* Michx.; *Polygala verticillata* L.; *Prenanthes racemosa* Michx.; *Gerardia aspera* Dougl.; *Vernonia fasciculata* Michx.; *Potentilla arguta* Pursh.; *Galium boreale* L.

These characteristics might well be pointed out on many of the Dakota hills, and they may possibly be shown to be peculiar to high-growing vegetation; yet neither in Minnesota nor in Dakota have I ever seen so many plants varying so widely as on the crest of the Coteau des Prairies in Minnesota.

April, 1892.

[*Paper D.*]

THE SAINT PETER SANDSTONE.*

F. W. Sardeson.

Introduction.......... 64
Thickness.......... 65
Geographical Distribution.......... 65
Geological Distribution.......... 66
Structure.......... 68
Lithologic Characters.......... 67
Paæontologic Characters.......... 68
  Discovery of Fossils.......... 68
  Condition of Preservation. 69
  Description of Species.......... 70
  General Discussion of.......... 79
Physical Relations.......... 80
Stratigraphic Position.......... 82
Correlation.......... 83
Origin (Theories).......... 84
Bibliography.......... 87

INTRODUCTION.

The name of this formation was written Saint Peter's Sandstone by its author, Dr. Owen, and some geologists still retain that form of the name. The amended form, Saint Peter, has however long been used, and is preferred. The name was adopted by Owen because of the good exposure that is situated at the mouth of the Minnesota river, which last in Owen's time was called the Saint Peter's. The city that was of the same name as the river formerly, is now called Saint Peter.

The type exposure of the formation was chosen because of its situation at the military post, Fort Snelling. It is typical, and a description of it sufficed to enable geologists to recognize the same formation at any other of the many exposures, which occur over a large area. Even the earliest descriptions of this sandstone are free from confusion, both because its very peculiar characters excited close attention, and because those characters are so persistent that recognition of the formation was nowhere difficult. In fact, owing to the persistency of its characters, descriptions of it, although drawn from different regions, are monotonously similar. The little variation that does exist seems to be intended to relieve monotony rather than add to scientific knowledge. The formation is noticeably lacking in mineralogical, petrographical, stratigraphical and palæontological diversity.

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* Owing to unavoidable delay in the publishing of this paper, it has been necessary to revise it. It was first delivered to the Society November 13th, 1892. The revised copy was given to the Secretary of the Society November 13th, 1895.

THICKNESS.

The Saint Peter sandstone was supposed by James Hall (9)* to be remarkably uniform in thickness, ranging from 80 feet in its northern (Minnesota) exposures to over 100 feet in the southern (Illinois) ones. In a sense, it *is* remarkably uniform, for the thickness in one area of its great extent averages nearly the same as in any other. But Worthen (12) found this formation to be variable in depth in Illinois, and Chamberlin (21 and 26) has clearly and concisely shown that it is in fact not uniform, but very variable in thickness, even within short distances. This variability is due to the undulated surface of the dolomite upon which it rests, the undulation being so great as to cause the depth to vary from less than one to over 200 feet. The mean thickness has been estimated by Chamberlin (26) to be between 80 and 100 feet. It is more than 100 feet thick in the north.

These estimates are for the Saint Peter itself, exclusive of the Shakopee dolomite and New Richmond sandstone, which two formations McGee (31) Keyes (32) and Norton (33) have, for Iowa, included in the Saint Peter. Such a course is not warranted; when followed, care should be taken to add to the Saint Peter the thickness of the never-failing Shakopee beneath, lest a false meaning be given to already established data, as it has never been shown that Saint Peter and Shakopee taken together are ever reduced to marked thinness. No regularity for the undulations in the underlying dolomite has been observed, hence no explanation for the variability in the thickness of the Saint Peter sandstone is yet known.

GEOGRAPHICAL DISTRIBUTION.

The Saint Peter sandstone is seen in numerous exposures in southeastern Minnesota, in northeastern Iowa, in western southern and eastern Wisconsin, and in northern Illinois. In this wide area it is repeatedly interrupted or reduced to isolated areas by river valleys.

The original extent of the formation we do not know. The general northern edge of its area, presents an eroded, torn and glaciated margin which is very far from being the limit of the formation that must have existed at the time of its deposition. It probably extended a considerable distance northward. On the other hand the general southern extent is so deeply buried below the earth's surface that the limits to the southeast, south and southwest are undiscovered. Our knowledge is in fact confined to a relatively small fraction of the Saint Peter. The surface exposures as well as the area in which these exposures are found are narrow, from reasons that will be given below.

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* The numbers refer to the bibliography at the end of the paper.

GEOLOGICAL DISTRIBUTION.

So far as we know, the Saint Peter was primarily coextensive with the overlying Trenton (Galena) and the underlying Shakopee. The now existing difference in extent is due to erosion, which of course has worked upon the uppermost strata to the greatest degree and it has caused the undermost—Shakopee—to have a few miles widest extent northward, as seen upon maps of the region.

The inequality in extent of these three Lower Silurian (Ordovician) formations is due very often to erosion that is still going on, very much also to glacial and preglacial erosion. In the latter case the once denuded area may be entirely covered with drift. How long ago the preglacial erosion took place is uncertain. An important and interesting addition to our knowledge is afforded, further, by the existence of a small area of Cretaceous clays (28, pl. 3) in Goodhue county, Minnesota, which lie upon the Saint Peter and Shakopee, the Trenton and other formations having been removed before the Cretaceous was deposited.

The situation of this small Cretaceous area at a high elevation, on top of the ridge near deep river valleys suggest that the valleys have been eroded mainly *since* Cretaceous time, and also its position upon an already eroded surface many miles within the present outer limits of the Saint Peter sandstone proves that the latter formation had been greatly eroded even *before* Cretaceous time. We learn from Worthen (12) that in a few exposures in La Salle county, Illinois, the Coal Measures rest immediately upon the Saint Peter sandstone; from this it is to be inferred that the overlying Trenton had been removed during the Devonian or, more probably, the early Carboniferous period.

From the fact that no Saint Peter sandstone has yet been reported from the Upper Peninsula of Michigan, it has been thought probable that a limit to the formation exists in that direction, and one which existed necessarily before the Trenton was deposited, since the Trenton is still there. It is possible that failure to report is due to failure to observe.

The known limits of the Saint Peter sandstone are those that have been produced by erosion, along the northernly and more elevated extent of the formation; the unknown limits are in the direction of the dip of the sedimentary rocks, i. e., in a general southeast and southwest direction. The Saint Peter may be continuous with formations of other adjacent areas but it has not yet been traced, nor as it would seem, satisfactorily correlated.

LITHOLOGIC CHARACTERS.

The Saint Peter sandstone averages about 99 per cent. silica in the form of grains of clear limpid quartz. There is very little cementing material of any kind so that it forms a "very friable stone . . . . . so loosely united that it appears like sand" (Keating, 4). The grains are typically clear white but the sand is often stained yellow or red locally. It is rarely cemented into a firm rock by an infiltration of iron oxide. Rarely also calcium carbonate infiltration has produced large concretions and areas of firm white rock. Normally it is easily eroded.

The sand grains are so much worn that they are nearly round and have a dead polish. Chamberlin (26) describes them as irregularly angular grains like the quartz from eroded acid eruptives and rarely of true crystalline form. The writer has found quartz crystals; but since the zones in which they occur, cross sometimes the sedimentary lamination instead of coinciding with it they are to be considered as originally rounded grains which have been rebuilt to perfect crystals. The rounded grains are the typical ones. In size, they vary from finest dust to coarse sand, 1 to 2 mm. in diameter, intermixed or imperfectly assorted. The dazzling white color gives the appearance of greater uniformity in size of grain than really exists.

An intermixture of argillaceous bands has been described (21) from northeastern Wisconsin; such an intermixture is generally found at the upper and lower limits of the formation. But, the Saint Peter Sandstone proper is a pure, friable, white rock with very little impurities. It is thoroughly pervious to water, so much so that a small stream poured upon the surface of a slab readily goes through it.

STRUCTURE.

Ordinarily the clear whiteness of the sandstone conceals its structure; on the other hand the infiltrated colors bring it out the more strongly. Stratification is always discernible often with fine lamination, crossbedding, and assorted layers of coarse and fine material. Transverse fissures also occur.

PALAEONTOLOGIC CHARACTERS.

Discovery of Fossils.

Owing to the friability of the rock and the total absence of shells, fossils are difficult to find. James Hall writes in 1862, (loc. cit.) that "no vestige of an organism has been observed" and "it is not probable that such remains will be found." Some years afterwards, however, N. H. Winchell (17.) reported shells of a *Lingulepis* from the top shaly strata of Saint Peter at Fountain, Fillmore county, Minnesota. T. C. Chamberlin (21 and 26) found worm burrows and fucoids near Beloit and Waterloo, Wisconsin, and these are reported by him to be not entirely in the uppermost strata of the formation.

Joseph F. James (34 p. 126) reports that he visited Fountain, Minnesota in 1889 and collected specimens of the *Lingulepis* and an *Orthis*. I have myself later collected the same and some other species at that locality in the described upper shaly strata. Species have been collected from similar strata near Dodgeville, Wisconsin. These fossils are all from the transition strata at the top of the formation, i. e. at the base of the Trenton.

Several species do occur in the body of the formation. As a student working under the direction of Professor C. W. Hall, I found in the year 1890, a large fauna in the Saint

Peter Sandstone, near Saint Paul, Minnesota. A notice of the same has been published (29). Fossils can be found still at the same localities. At Dayton's Bluff, the "Carver's Cave" of early writers, fossils were found between 60 to 80 feet below the overhanging Trenton, or Buff Limestone. A second exposure at Highland Park two miles south of the first is in strata lower than any at Dayton's Bluff, and here also fossils were found. At a third exposure, which is near South Saint Paul, there were found by Professor C. W. Hall and by myself a large number of species, in strata that are probably intermediate between those of Highland Park and Dayton's Bluff.

Condition of Preservation.

The fossils are found as casts of shells that have themselves been entirely dissolved without leaving even a stain of color or a trace of calcium carbonate in the sand. The cavities left by the shells are closed up by a consolidation of the sand in some manner so that generally little more than smooth cleavage planes remain to define the fossils. In the strata that are referred to the upper half of the formation, the fossils were nearly always free from distortion. In the lower half on the contrary, few are not distorted. Here too there were found fossils which are the moulds only, of the casts of shells. The moulds were full of loose sand, which when removed simply by blowing and shaking, left smooth cavities in exact form of the interiors of shells themselves. The loose sand in the moulds was probably once embedded in the casts of shells. The process of fossilization must have been nearly as follows: A shell produced a cast, and was later dissolved away. The inner cast of the shell remained firm while the sand around it was disturbed and pressed around the cast taking the mould of it. The cast itself was then reduced by removal of the calcium carbonate to loose sand, the mould, however, remaining firm because already consisting only of sand.

Similar phenomena are to be observed in dolomitic limestone. The fossilization itself is not strange, but it reveals to us perhaps the reason that Saint Peter sandstone is so generally unfossiliferous, viz.: Because the fossils have been destroyed since the sandstone was deposited. One might dig up many fossils without seeing them unless care be taken to prevent the casts from being crumbled. The most favorable conditions are in the somewhat infiltrated strata where firmness is secured.

In many cases the shells of bivalves are found in such a manner as to prove that the ligament still bound them together at the time they were deposited in the sand. Of course such shells could not have been transported far nor much beaten about otherwise they would be found separated. Many of the shells were undoubtedly very thin and fragile.

LAMELLIBRANCHIATA.

Genus CYPRICARDITES.

Cypricardites (*Vanuxemia*) *fragosus* n. sp.

Plate II, figures 1, 2 and 3.

Cast acutely ovate in outline. Beaks extendfng beyond the anterior end of the hinge, gently curved, gradually expanding, and swelling out dorsally above the cardinal line. Casts concave under the beaks. Cardinal line curved and extended into an alate projection at the anterior end in front of the beaks but rounding evenly into the semicircular posterior margin. Antero-ventral margin slightly curved. The anterior alation contains the cardinal teeth four or five in number and has a very deep muscle scar just below it. Posterior muscle scar and posterior teeth not known. Along the anterior margin the shell is concave, between the beaks and the posterior ventral portion it is convex, end strongly so along the cardinal region. Transverse length of largest specimen 30 mm., breadth greatest at the posterior extremity of the hinge (18 mm.), convexity of single valve 12 mm. Shells probably very thick.

Found at Highland Park and South Saint Paul.

Cypricardites descriptus n. sp.

Plate II, figure 7.

Small, strongly convex, subquadrate, length 11 mm, breadth 9 mm. Beaks anterior, acute curved in. The point of greatest convexity is near the umbones, and the slope to the ventral margin is gradual. Cardinal line gently curved. Pallial lime simple and marked. The posterior muscle scars large, situated just below the extremities of the hinge. Surface smooth.

Highland Park.

Cypricardites finitimus n. sp.

Plate II, figure 6.

Shell of medium size, oblique, moderately convex, broadest posteriorly. Beaks broad, a little projecting, and slightly coiled. The point of greatest convexity is central. Anterior muscle scar prominent. Surface of the cast is concentrically marked by growth lines which appear to show the ventral margin a little more convex than on the figure. The only specimen found is a little compressed, and moreover does not show clearly but that it may be a modiolopsis.

Highland Park.

Cypricardites dignus n. sp.

Plate II, figures 4 and 5.

Shell rhomboidal, with the ventral margin longest; length of the largest specimen 18 mm, bredth 12 mm. Beaks anterior, tumid, close together. The hinge line is equal to about two-thirds the length of the shell, is curved and apparently continuous with the anterior margin. In general direction the anterior margin is vertical, but forms a strong even curve, which same is continued, but less strongly, through the ventral margin to the postero-ventral angle. The dorsal margin is more distinctly marked off but is gently curved. The point of greatest convexity is between the umbones and the centre of the shell along the rounded umbonal ridge which extends from behind the beaks obliquely back to the postero-ventral angle. Anterior to this umbonal ridge the shell is evenly and strongly convex, but between it and the dorsal and posterior margins the surface is concave. In general the specimens resemble *Nuculites inflatus* Emmons' Geo. Rep. N. Y., p. 395, fig. 2, but have a more prominent anterior margin and less produced hinge posteriorally. *Edmondia subtruncata* Hall Pal. N. Y., Vol. I, p. 156, and plate 34, fig. 9, (not plate 35, fig. 3, c.) is very much like the specimens from the Saint Peter but is larger and proportionally longer.

South Saint Paul.

Genus MODIOLOPSIS.

Modiolopsis fountainensis n. sp.

Plate IV, figure 7.

The few specimens secured resemble *Modiolopsis plana* Hall, of the Trenton limestone which lies upon the Saint Peter sandstone. The Saint Peter specimens are larger casts, however, and have the beaks situated further back and erect instead of directed forward. The convexity of the shell was not strong but there was a broad deepening between the beaks and the lower posterior curve of the margin, accompanied by a straightening of the ventral margin. The anterior muscle scar is large and close to the anterior margin. The specimens were found with *Lingula morsii* N. H. W. at the top of the Saint Peter formation (see pl. IV, fig. 9, c.) below Fountain, Minn.

Modiolopsis postica n. sp.

Plate IV, figure 8.

Shell about 50 mm. long, width greatest across the posterior half (30 mm.) The hinge line is nearly straight. The beak, of the left valve here described, is obtuse, broad and close down to the hinge. The umbo is high but flattened anteriorally and is continued in a rounded umbonal ridge towards the dorso-ventral margin and in a broad depressed area towards the ventral margin. The posterior margin is broadly rounded and is continuous with the ventral margin, which in turn continues with the anterior forming a sigmoid curve. The surface of the cast is marked by fine concentric lines. All the specimens collected are imperfect and none show the anterior perfectly. The specimen figured is from the transition strata of the Saint Peter about four miles below Dodgeville, Wisconsin, along the Illinois Central railway tracks.

Modlolopsis litoralis n. sp.

Plate II, figures 13, 14, 15 and 16.

The figure represents an interior cast of average size and form of this species. The casts are all strongly convex between the umbones and the lower posterior margin, forming a broad umbonal ridge, and a broad sinus, as well as a straightening of the posterior margin. The beaks are indistinct but extend longitudinally and project above the hinge. One strong anterior muscle scar is situated apparently just at the anterior end of the hinge. Compare *Orthodesma curvatum* H. and W. Pal. O. II, p. 95.

From South Saint Paul and Highland Park.

Modiolopsis contigua n. sp.

Plate II, figure 8.

Shell small, length about 25 mm., bredth at the posterior extremity of the hinge, 15 mm., at the umbones about 9 mm. The hinge is somewhat curved and is in some specimens longer posteriorally than in the one figured, and in these it forms an obtusely rounded angle with the posterior margin. The ventral margin is concave or straight, the anterior margin short and strongly convex. The beaks are somewhat obtuse and are directed forward. Their posterior half swells into a high rounded umborial ridge that extends towards the posterior-ventral margin while the anterior half is flattened continuous with the concave area anterior to the umborial ridge. The greatest convexity is at one-third the distance from the umbones towards the lower posterior margin. The shell has been very thin and marked with growth lines. It differs from *M. plana* Hall, in being proportionately narrower and having a stronger umbonal ridge and more concave ventral margin. From *M. similis* Ulrich it differs by the same characters. The type specimen is a relatively broad one.

Found at South Saint Paul.

Modiolopsis gregalis n. sp.

Plate II, figures 10, 11 and 12.

Length about 25 mm.; bredth 12 mm. and greatest at the middle; beaks less than one fifth the distance from the anterior end, small, incurved and scarcely projecting. Hinge line nearly straight; dorsal margin rounded gently from the hinge but more strongly so near the ventral margin; ventral margin gently arcuate and gradually rounding up continuous with the anterior, which in turn curves abruptly at the antero-dorsal end. Convexity moderate and uniform except for a low broad umbonal ridge which extends from below the beaks towards the lower part of the posterior margin. Point of greatest convexity just above the centre. One reniform anterior muscle scar near the anterior end, close to the pallial line. Pallial line simple, and marked off by a marginal thickening of the shell.

Mopiolopsis subelliptica Ulrich, as described* is the nearest to this species of any known. The difference in size, the position of the muscle scars and the beaks, and the difference in outline and convexity are apparent but the resemblance is great. The specimen is about medium size.

South Saint Paul and Daytons Bluff.

Modiolopsis affinis n. sp.

Plate II figure 9.

Cast of medium size, length 15 mm, bredth 8 mm, beaks about one fifth the distance from the anterior end, not prominent, but strongly curved. The hinge line is curved and runs gradually into the truncate posterior. The ventral margin is arcuate, and the anterior semi-circular. The convexity is greatest anteriorly and along the strong umbonal ridge which extends down and back to the extended end of the shell at the ventral posterior margin. Above the umbonal ridge the shell is gently concave while below and parallel with it the cast is flattened. The pallial line is not distinct.

The above description is of a single specimen which very much resembles *M. gregalis* but is more convex in the anterior portion and has a strong umbonal ridge and some indications that the shell was marked by coarse elevated lines radiating from the umbonal ridge. The general outline of the cast led to the expectation that specimens intermediate in form would link this with *M. gregalis* n. sp. but although a large number of specimens of the latter have been found, the distinctive characters still remain.

South Saint Paul.

Modiolopsis senecta n. sp.

Plate II, figure 17.

Shell large, length 33 mm, bredth 15 mm, convexity very moderate, but slightly increased between the umbones and the posterior extremity. Hinge straight and long. The ventral margin arcuate and it extends uniformly to the longitudiual extremities of the shell so that the anterior and posterior margis are short obligue truncations. Pallial line and muscle scars not visable. Beaks not projecting, low, and placed far anterior. Only one specimen found.

South Saint Paul.

GENUS TELLINOMYA.

Neither of the two species referred to this genus have the characteristic hinge teeth clearly preserved, but that is evidently because the sediment or sand was too coarse to preserve a cast of such minute structure.

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*Ext 19th Ann. Rep. Minn. Geol. Sur. March 3rd 1892

Tellinomya novicia n. sp.

Plate III, figure 3.

Length about 12 mm, bredth 8 mm, convexity of a single valve 3 mm. The beaks are prominent, curved, situated about one-third the length from the anterior end, and directed a little forward. Between the beak and the ventral margin the convexity is strong but uniform, while anteriorly and in the postero-dorsal direction the convexity is abrupt, giving the cast a triangular appearance. The hinge is about 8 mm long, curved and elevated posteriorally so as to form a concave surface below it. The pallial line is simple and well marked. The anterior muscle scar is large, round and placed midway below the beak, and tangent to the pallial time, which seems here to form a sort of clavicle. Posterior scar not distinct.

Found at South Saint Paul and Dayton's Bluff.

Tellinomya absimilis n. sp.

Plate III, figures 1 and 2.

Length about 20 mm, bredth 10 mm. Beaks anterior, small and curved close down to the hinge. Hinge, posterior to the beaks, is nearly straight and is long; anteriorally it is short and curved down, in continuation with the anterior margin, which is nearly straight above but curved abruptly back below forming an acutely rounded antero-ventral projection. The ventral margin is gently convex for the anterior half, gently concave to the posterior extremity, but in general direction is parallel to the cardinal line. The posterior margin is nearly straight, is well marked off from the ventral and dorsal, and forms an angle of about 110° with the latter. The point of greatest convexity is at the umbones anterior to the strong acutely rounded umbonal ridge which runs obliquely back forming the postero-ventral angle and giving a convex slope to the postero-dorsal and postero-ventral portions of the shell. Below the umbones the shell is strongly and evenly convex. The shell was thin and marked by fine plications which radiate from the umbonal ridge. The dentition is that of a *Tellinomya* but not distinctly preserved.

Highland Park.

GASTEROPODA.

GENUS HOLOPEA.

Holopea cf. obliqua Hall.

Plate III, figure 5.

Compare *Natica* (species undetermined) Hall 1847, Pal. N. Y., vol. 1, p. 42, pl. 10, fig. 4, and *Holopea obliqua* Hall 1847, Pal. N. Y., vol. 1, p. 107, pl. 37, fig. 2.

Small, of about three or four volutions, the last of which forms the main body of the shell. Volutions evenly ventricose above. Sutures well marked. No umbilicus. Surface with ridges of growth which run directly transverse. Apical angle about 115°. Three specimens have been found all of which are imperfect. There is no umbilicus, but in other respects they are exactly like *H. obliqua* Hall with the lower part broken off. In vertical sections of *H. obliqua* Hall from the Stictopora bed of the Trenton in Minnesota, the umbilicus was found to extend through the last or last two volutions only. There seems to be nothing that indicates a distinction between these specimens and *H. obliqua* as found in the Trenton of Minnesota.

South Saint Paul.

Holopea paludiniformis Hall.

Holopea paludiniformis Hall 1847, Pal. N. Y., vol. 1, p. 171, pl. 37, fig. 3.

One specimen indentical with the upper volutious of *H. paludiniformis* is imperfect but differs in no way that can be seen, from specimens that occur in the "Lower Blue Bed" of the Trenton limestone at Minneapolis.

Found at South Saint Paul.

GENUS MURCHISONIA.

Murchisonia cf. *gracilis* Hall.

Plate III, figure 4.

Murchisonia gracilis Hall, 1847. Pal. N. Y., vol. I, p. 181, pl. 39, fig. 4.
Murchisonia gracilis Salter, 1859. Can. Org. Rem., Decade I, pl. 5, fig. 1.
Murchisonia gracilis ? Whitfield, 1882. Geo. Wis., vol. IV, pl. 5, fig. 19.

Several imperfect specimens have been found that approach *M. gracilis* Hall, but that have the whorls less oblique, and also were much larger when perfect than those in the Trenton and Hudson series of Wisconsin and Minnesota. The specimen figured here has been distorted so that the whorls appear too little oblique and the spire too broad. Other specimens show that there were four or five more volutions below and there must have been as many more to form the upper part of the spire. They resemble in every way the figure of *M. gracilis* (Hall) Salter, from the Chazy or Black River limestone at Paquette's Rapids, Canada. But this is larger, with more numerous whorls and a greater apical angle than those of the Trenton of Wisconsin and Minnesota, and it seems to differ in the same way from Hall's figures of Trenton specimens from New York.

Murchisonia cf. *tricarinata* Hall.

A specimen probably belonging to this species was found at Highland Park and was identified by me, but was afterwards destroyed accidentally so that more exact comparison with the typical Trenton species is no longer possible.

GENUS OPHILETA.

Ophileta fausta, n. sp.

Plate III, figures 8 and 9

Coil of about three volutions nearly in the same plane; spire concave, the sides forming an angle of about 45°. The umbilicus is difficult to distinguish from the concave upper surface except by noting the direction of the aperture. The outer surface of each volution is gently convex, and joins to the upper and lower surfaces by acutely rounded angles, the lower one of which is perhaps a little the stronger. The upper and lower surfaces of each coil are about equally convex, and are nearly straight. The inner surface is quite straight, is equal in length to one-fourth the outer surface, and equal to once the outer surface of the volution with which it is in contact· Sutures deep on the cast. Surface smooth but marked by five transverse lines which run a little forward from the suture to the upper outer angle, thence obliquely down and back to the lower outer angle and from there curve a little forward to the contact with the penultimate whorl. Shell probably very thin.

Highland Park.

GENUS PLATYCERAS.

Platyceras vetulum n. sp.

Plate IV, figure 1.

Several specimens have been found which appear to belong all to the same species, although they vary in the form of the aperature and convexity of the body whorl, owing partly to distortion. In general the casts show that the shells were small, dextrally coiled, and had the body whorl proportionally very large. The spire or apex is not well preserved in any of the specimens, but was low, scarcely rising above the body whorl, and con sisted of one, possibly two whorls. The aperature was ovate, narrowest on the side next the spire, and strongly indented by the penultimate whorl. The plane of the aperature is nearly parallel to the axis of the spire.

There is some resemblance in this species to very rapidly expanding shells of the genus *Holopea*. Unfortunately no specimens could be found sufficiently well preserved, and not enough of them, to allow of good generic diagnosis. The figure is of a large specimen.

Found at South Saint Paul.

GENUS PLEUROTOMARIA.

Pleutoromaria aiens n. sp.

Plate III, figures 16 and 17.

Shell large, consisting of about four volutions which are rapidly expanding and ventricose. The first volutions on interior casts are evenly rounded, but the last one on large specimens has a broadly rounded carina a little below the middle. Apical angle 120°. Suture deep. Aperture large, indented on the inner side by the penultimate volution. The margin curves back from the suture for nearly one-fourth of the last volution and then forward an equal distance, making a deep, rapidly narrowing fissure, the rounded apex of which torms the longitudinal ridge. The umbilicus is large and opens nearly to the apex. No surface markings except irregular growth lines.

Highland Park and South Saint Paul.

CEPHALOPADA.

GENUS ORTHOCERAS.

Orthoceras minnesotense n. sp.

Plate III, figures 11 and 12.

The only specimen is a fragment of the septate portion of the shell. In the length of about 30 mm. the dorsal and ventral sides converge from 30 mm. to 23, and in that length there are included eight septa. The transverse section is oval, probably broadest above. And the siphuncle, which is about five mm. in diameter, is placed five or six millimeters above the lower surface. The septa were strongly convex, and on the cast the sutures are seen to have been curved backward on the sides as shown in the figure. The surface was smooth and the shell very thin.

Found at South Saint Paul.

Orthoceras (?) sp. undet.

Plate III, figure 10.

Compare *O. montrealense* Billings, Canadaian Naturalist, vol. IV, p. 361.

A fragment of the shell showing numerous septa and fine longitudinal striæ and enough only to show what the circumference probably was is all that has been found ol this species.

Highland Park.

Orthoceras sp. undet.

Plate III, figures 13 and 14.

This is a fragment probably of the siphuncle of an Orthoceras which shows no diminution in size at either end. The under side is the exact reverse of the side figured. It has probably suffered from compression since becoming fossilized.

From Highland Bark, Saint Paul, Minn.

BRACHIOPODA.

GENUS CRANIA.

?*Crania reversa* n. sp.

Plate III, figures 6 and 7.

A single cast of a shell marked only by very indistinct concentric lines, with a nearly conical outline and centrally placed apex, has been found. Besides the general outline of a *Crania* it has what are probably a pair of large muscle scars, 1.5 mm. in diameter at half way between the apex and the posterior margin and about one mm. apart. Other characters can not be observed, but this appears to be the ventral valve of a *Crania*.

Found at Highland Park.

GENUS LINGULA.

Lingula morsii N. H. Winchell.

Plate IV, figures 2 and 3.

Lingulepis morsensis N. H. Winchell, Fourth Annual Report of the Geological and Natural History Survey of Minnesota (1876), p. 41, fig. 6, a, b, c.

Lingulepis morsii (Winchell) S. A. Miller (1889), American Geology and Paleontology, p. 352.

A few specimens of this species have been found near Fountain, Fillmore county, at the same exposure from which the type specimens are said to have been collected. They differ somewhat from the original description and figure but are no doubt the same. The shells are cuneate in outline, moderately convex, with an apical angle of about 50 to 60° (26°, Winchell). The surface is smooth, with but slight concentric growth marks, and of the usual green color, although in most specimens a deep iron coloration has taken place. Radiating (not concentric) elevated rounded striæ are present, strongest near the anterior margin.

The specimens figured are from one of the strata (*c.* fig. 9, pl. IV) of the transition at the base of the Trenton (Galena) group, near Fountain Minnesota.

GENUS ORTHIS.

Orthis perveta ? Conrad.

Plate IV, figure 4.

An imperfect specimen only was found, but so far as can be seen it is like those that occur in the Buff limestone of the Galena series, that rests above the shale [See pl. IV, fig. 9, c.] in which this one was preserved.

BRYOZOA.

GENUS PTILODICTYA.

Ptilodictya ? sp. ?

Plate III, figure 15.

The drawing illustrates an iron-stained imprint found at Highland Park. No distinct characters remain on the fossil except the ramose outline, and evidence that it was flattened in one dimension like some of the Bryozoa so abundant in the Trenton series.

PORIFERA (SPONGIA).

GENUS RAUFELLA.

Raufella ? *fucoida* n. sp.

Plate IV, figures 5 and 6.

The figures are of casts found at Fountain, Minnesota, associated with, even containing, fragments of *Lingula morsii* N. H. W. They have some imperfect surface marks which, together with the general form, suggest that they represent Porifera, the walls of which have served to mould sand into internal casts and have since entirely disappeared. The casts are cylindrical and branched at regular intervals like *Raufella filosa* Ulrich and some other sponges of the Trenton series, and very much like an undescribed species very abundant and associated with *Licrophycus ottawaense* Billings in the Fucoid bed.

General Discussion.

The species are, therefore, distributed paleontologically as follows:

MOLLUSCA—	Lamellibranchiata—	*Cypricardites,*	4 species.
		Modiolopsis,	7 species.
		Tellinomya,	2 species.
	Gasteropoda—	*Holopea,*	2 species.
		Murchisonia,	2 species.
		Ophileta,	1 species.
		Platyceras,	1 species.
		Pleurotomaria,	1 species.
	Cephalopoda—	*Orthoceras,*	3 species.
MOLLUSCOIDEA—	Brachiopoda—	*Crania, ?*	1 species.
		Lingula,	1 species.
		Orthis,	1 species.
	Bryozoa—?	doubtful,	1 species.
PORIFERA—	?	cf. *Raufella,*	1 species.
	Total,	14 genera,	28 species.

All the species of the Saint Peter sandstone are very similar to others in the overlying Trenton limestone. In fact, if all had been found in some stratum of the lower part of the Trenton (Galena) series instead of in the Saint Peter formation, their occurrence would not have been thought surprising. The similarity with Trenton species is far greater than the lithologic difference of the two formations had led geologists to expect. But the Saint Peter fauna is only molluscan, i. e., there are wanting in it the Coelenterata, Bryozoa, Crinoidea and Trilobita which are so abundant in the Trenton. These conditions seem to prove that a physical much more than a time break separates the two formations, for the species are but little different while the faunas as a whole are widely different. A comparison with the formation that underlies the Saint Peter, shows an opposite relation. The Shakopee fauna, so far as the writer has found, consists of a few species of Gasteropoda and Cephalopoda. It is like that of the Saint Peter sandstone in being molluscan, but the individual species are different, being of the Upper Calciferous type. It can be argued from these considerations that the Saint Peter is separated from the Shakopee rather by a time gap than by physical changes. The paleontological evidence is not to be exclusively relied upon, since it is drawn from too few specimens and these not all of the very best kind. But the evidence as we have it agrees essentially with that found by stratigraphical and lithological comparison.

PHYSICAL RELATIONS.

There is in general, an upper and lower division of the Saint Peter sandstone, as has often been suggested by writers who have studied the lithologic characters of the formation, and I can see also a faunal difference, although not a wide one. No one has ever found an exact division, however, even in a single locality and a division of the whole formation is not at all practicable. It must be considered for the present, at least, as an undivided unit. The extreme upper portion of the Saint Peter has been described sometimes as a transitional zone, which it really is, but whether it is clearly distinguishable as such from the main formation is not certain. At Fountain, there are such strata which could be arbitrarily separated where the shales begin, (see fig. 9, pl. IV). But these strata are not constant for any considerable distance. There are also transitional shaly strata with intermingled sand grains at the top of the Saint Peter at Minneapolis, which contain only Trenton fossils and belong to the Trenton. Transition strata are usually found but they are not necessarily equivalent those in one locality with those of another.

The Trenton has been everywhere conformably laid upon the Saint Peter sandstone, with usually a short transitional zone between them. Where the Trenton has been eroded away, the Drift, the Cretaceous, or the Carboniferous rests unconformably upon the Saint Peter, as already described above under the head of Geological distribution.

Upon the relation between the Saint Peter and the Shakopee below it geologists are not agreed as they are upon the transition between Saint Peter and Trenton. McGee (31) Keyes (32) and Norton (33) agree in pronouncing the Shakopee inseparable from the Saint Peter and include the former in the latter. They say that the former really passes by degrees into the latter. This theory does not agree with observations made by other writers. Hall in 1852 (9) describes this transition as abrupt. Chamberlin (21) says that brecciated pieces of dolomite occur in places in the lowest stratum of Saint Peter. Irving (22) writes that "between the periods of deposition of the lower Magnesian and the Saint Peter there was a long gap whose record is in the eroded surfaces of the first named formation." Moses Strong (23) held a similar view. Chamberlin, who wrote later (26) corecting the theory that the great inequality at the top of the "Magnesian" was due to erosion, and showing that the undulating surface was really due to folding of the upper part of the "Magnesian" i. e. Shakopee, still does not contradict Hall's statement that the transition is abrupt. I have not observed a real unconformability between the two formations but such may exist, and the contact has been found an abrupt one as often as observed at all. In Iowa no exposed contact has yet been found by me. The Shakopee consists not only of dolomite but of more or less sandy strata and sometimes clay, and it may be that these sandy strata have been considered as a continuation downwards of the Saint Peter, a view that would require first other evidence to prove. It is contradicted really by the paleontological and stratigraphic evidence that we now have.

The Saint Peter folds conformably with the Shakopee, and the contact can be sometimes at least exactly marked because it is an abrupt transition. It is also conformable to the Trenton with a transition of alternating strata or of mixed materials. The Shakopee and Trenton are not however parallel to each other, for as well known the former is much folded while the latter is almost exactly horizontal, the Saint Peter between them being consequently of unequal depth. It was naturally supposed by geologists that the folding of the Shakopee was completed before the deposition of the Saint Peter began and that may still be supposed correct in part but not entirely.

Figure 10, plate 4 is a sketch of an exposed contact of the last member of the Magnesian series (i. e. Shakopee proper) and the base of the Saint Peter formation, as seen along the Illinois Central Ry., at the crossing of the Chicago Milwaukee and Saint Paul Ry., in LaFayette county, Wisconsin, a few miles north of the Illinois-Wisconsin state line. It represests one of the extreme cases of folding seen in the Peccatonica valley and is chiefly interesting in that the two feet of shale which is always found at the top of the Shakopee in that region is preserved beneath the sandstone undiminished except by compression. Had the folding taken place before a considerable depth, 20 feet or more, of sand was deposited, the shale would have fallen from the eminence by its own weight or at least been washed down by the water. The sandstone in this exposure is somewhat confused by compression yet it can be seen that here as at other exposures in the Peccatonica valley the stratification of the Saint Peter is conformable to the Shakopee. The upper surface of the Shakopee i. e. at the contact, is ripple marked.

There are small faults as described in a former paper (see 30., p. 354. fig. 4.) which extend upwards from the base of the Saint Peter formation through the sandstone, about half way up to the Trenton.

These phenomena were considered to be evidence that the Saint Peter was deposited partly before and partly after the folding of the Shakopee. Of this I shall speak again in discussing the origin of the sandstone.

STRATIGRAPHIC POSITION.

The position of the Saint Peter is of course clearly, between the Lower Buff limestone of the Galena (Trenton) series above, and the Shakopee dolomite of the Magnesian series below. It is conformable to both. Paleontologically it is closest united to the Galena (Trenton) series above it. Lithologically it belongs to the "Magnesian" series with the Shakopee, for it stands as the last of that series of sandstones and dolomites, and does not unite with the Galena (Trenton) series which consists of limestones and clays without sandstone. A time break seems to separate the Saint Peter from the Shakopee, while a physical revolution separates it from the Galena series. It thus appears to be a transition formation between the Magnesian series or Upper Cambrian and the Lower Silurian, and it has been so considered (30).

But that the Saint Peter represents the lowest member of the Ordovician (Lower Silurian) as understood by that term in England and in New York, is not unconditionally asserted. In fact, the Shakopee may be proved to be the lowest member of the Ordovician, when more exactly correlated.

CORRELATION.

The period to which the Saint Peter belongs is by far the most easily determined through its relation to the Galena (Trenton) series, which is richly fossiliferous. The Magnesian series also affords a means of determination because fairly fossiliferous. James Hall and J. D. Whitney (8) in 1858 correlated the Saint Peter, in this indirect way, with the Chazy of New York. Hall again in 1862 and in 1863 repeats it, and nearly all geologists have followed his correlation, hence the name Trenton, which belongs typically to a New York formation, has been equally applied to parts of the Trenton (Galena) series that overlie the Saint Peter. The Trenton series of New York and Trenton (Galena) series of the upper Mississippi valley are correlated. There is, nevertheless, diversity of opinion over the question, what part of the Galena (Trenton) series is equivalent to the Trenton formation proper of the New York Trenton series; what part equals the Black River formation; and what the Chazy.

By many geologists, the Galena (Trenton) series is believed to include only the equivalents of the Black River limestone and Trenton limestone proper, the equivalents of the former being called Trenton and that of the latter Galena limestone. The Saint Peter thus remains to be correlated with the Chazy.

This correlation cannot be said to be undoubtedly established, but represents the extent of our knowledge. It is here inserted because it takes the place necessarily of a direct comparison of the Chazy and Saint Peter faunas, both of which are relatively meagre.

The two formations, Shakopee and Oneota, beneath the Saint Peter faunally correlate well with the Upper and Lower Calciferous respectively, which underlie the Chazy proper, and they also correspond in their relation to each other and to the overlying formations.

Like that of New York, the formation called Chazy in Canada seems to hold a stratigraphic position comparable to that of the Saint Peter sandstone, and, as Joseph F. James (34, p. 131) has pointed out, it is in a way a transition between the Chazy proper and the Saint Peter, since it is neither chiefly limestone like the former nor pure sandstone like the latter, and since it lies geographically intermediate.

The Saccharoidal sandstone in Missouri* was believed to be the equivalent of the Saint Peter by Meek, as also by Shumard (loc. cit.), and more particularly by Worthen (12). In fact the Saccharoidal sandstone is lithologically and stratigraphically like the Saint Peter. Mr. Meek found fossils in it, but unfortunately they have never been described. No new evidence has since been added. Charles R. Keyes has recently doubted that the "Saccharoidal" sandstone is the representative of the Saint Peter in Missouri,† the latter being, as he thinks, either absent or represented by a limestone. He gives no reasons for this new departure.

ORIGIN.

Keating, who was surprised, like many other explorers, at the purity of the Saint Peter sandstone, mentions someone's theory "that this sandstone must have been formed by a chemical precipitation and not by mere mechanical deposition." (See 4, p. 330.) Owen, on the contrary, never mentions anything but sedimentary phenomena in his descriptions of the formation. Hall and Whitney (8) adopted the chemical theory to explain the purity, although apparently but once.

The Saint Peter sandstone is a mechanical sediment and consists of quartz grains such as come from the erosion and decomposition of acidic eruptive rocks (see Chamberlin, 26). Its structure is that of a mechanical sediment. It contains marine fossils. One must therefore explain the purity of the stone in some other way than that which explains the purity in salt and gypsum deposits. But no explanation offers itself readily.

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* See Geological Survey of Missouri, 1st Ann. Rep. (1853) pp. 117 and 197; 2nd An. Rep. (1854) pp. 105, 145 and 160.

† Missouri Geological Survey, vol. 4, pp. 30. 35 and 38.

In the first place, with the exception of the very small percentage of kaolin the impurities distributed through the Saint Peter sandstone can be and evidently should be considered as recent infiltrations. Therefore the stone was once an almost absolutely pure quartz. In the second place, there are fossil casts in the white sandstone; these must have been produced by calcareous shells, although the shells themselves have been dissolved away so thoroughly as to leave no stain nor trace of their substance. Still other fossils are moulds of former internal casts as already described. The moulds are now full of loose sand, which together with soluble materials, probably, for the most part, calcium carbonate, formerly composed the internal casts from which the moulds are preserved. The amount of quartz sand as compared with the now missing soluble materials, seems to be less than half the content of the moulds. The question suggests itself: Could the strata of the Saint Peter have been originally one-half calcium carbonate? Was the formation originally a calcareous sandy mixture, which later became pure quartz by the chemical action of water?

The Saint Peter strata constitute a sandstone in the highest degree porous and water flows through it readily, so that the very best circumstances for infiltration and exfiltration are now afforded by it. It could have been for long periods a perfect underground waterway. It is, in fact, situated next under a series of clay, marl, and limestone formations that are more impervious to water, while beneath it are sandstones and somewhat porous dolomites through which water could pass somewhat readily. The exposed, eroded, and glaciated border of these formations is at the same time their more elevated portion, so that water sinking into any of them would be carried deeper as it coursed in the direction of the stratification. The water in the Saint Peter would be held back by the impervious strata above it, while that in the strata beneath could break upwards through the dolomites and sands into the Saint Peter, which latter thus would be the main underground waterway. This may explain why the sandstone is now so pure, for much calcium carbonate and other constituents could have been carried from the formation by coursing waters.

Such considerations may be used to explain other phenomena as well. It has been shown that the folding of the Shakopee took place at last partly after the sandstone was deposited upon it. (See fig. 10, pl. 4.) The folding is similar to that produced by lateral pressure, except that for some reason the top and not the base of the Magnesian series is involved in it. The Shakopee is very strongly arched here and there and the top of the Oneota likewise, but before the base of the latter is reached the undulation disappears, except in one or two localities, near the city of Saint Peter, Minnesota, for example, and there the underlying Jordan sandstone is pure like typical Saint Peter. The Saint Lawrence formation is not seen to be folded.

In view of the facts as given above, I am constrained to set forth a theory, without, however, considering it as conclusively proved, that the purity of the Saint Peter sandstone, the paucity of its fossils and its variable depth are all due to the effect of percolating waters and were not original characters, and, further, that the supposed unconformability at its base may have been produced solely in this manner. That is, that the Saint Peter has simply had all soluble material washed out of it, that it is thus reduced in thickness, and that the now dolomitic formations immediately beneath have been attacked in a similar manner and reduced—the whole process causing a shifting of the sand sufficient to produce inequalities in its thickness.

The great mass of Silurian and Devonian rocks resting upon the Saint Peter have not been reduced in that manner, nor to the same extent, but have preserved an unbending crust, while the Middle Cambrian sandstones below the Oneota formation remained likewise rigid. Inequalities produced during the reduction of the Saint Peter and Magnesian series also must have caused shifting and readjustment, and naturally these would culminate intermediately between the firm overlying and underlying formations. that is, in the formations that were being most reduced. This may explain why the folding begins midway in the Oneota, culminates at the base of the Saint Peter, and ends below the top of the same.

Heretofore geologists have considered the Saint Peter sandstone as originally deposited in an almost chemically pure condition. One argument against this view lies in the peculiar preservation of its fossils. Again a fair degree of purity is generally found, and all the exposed portions of the formation alike exhibit the conditions necessary for the theoretical origin that has been pointed out. Still it remains that this formation is unique among the Mississippi valley sandstones of Eopaleozoic time.

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November 13, 1892.

[*Paper E.*]

THE RUM RIVER VALLEY AS A BOTANICAL DISTRICT.

E. P. Sheldon.

The Rum river, with its tributaries, drains the surface area of Mille Lacs, Isanti and Anoka counties. Besides this, portions of Crow Wing and Aitkin contributory to Mille Lacs lake, and the eastern edge of Morrison, Benton and Sherburne counties are in its drainage basin. The valley is thus seen to occupy a narrow strip lying between the Mississippi drainage on the west and the St. Croix on the east.

Within this narrow belt the most varied conditions for plant growth are offered. It is to be noted that this section is between that contributory area on the north and east from which we would most naturally expect the entrance of plants usually found occurring wherever large coniferous belts are extant; and the prairie-plant-contributing area on the south and west, from whence we would expect the great host of prairie composites, pulses, grasses, etc.

Viewed in this light a study of the plant immigrants now seeking a foothold in the valley becomes as interesting as a review of the endemic plants. But we must remember that in a very recent time in the history of our continent the plants now considered endemic were emigrants from the north, the south, the east or the west. And we must not forget that the section under consideration has in times past been subject to the same glacial action as most of our Minnesota natural drainage basins. Furthermore, the Rum river valley now lies between the old Mississippi drainage on the east—the present St. Croix—and the later and present channel on the west.

Then again birds have flown, waters have carried and winds blown for ages past even as they are doing to-day, all assisting in the constant dissemination of seeds.

Before enumerating some of the plants recently found in this section, it would, perhaps, be well to point out some of the conspicuous sylvan characteristics noted, with a view to showing what a diversity of conditions and consequent multiplied chance for plant establishment.

The pine-barren region characteristic around Brainerd and Aitkin barely touches the northern edge of the drainage north and west of Mille Lacs lake.

The straight, slender jack pine, *Pinus divaricata* (Ait.) Sudw., which is found in quite heavy groves in the localities above mentioned, occurs only locally south to Princeton. East of Mille Lacs lake miles of almost impenetrable swampland renders botanical investigation difficult. The timber of these swamps is largely larch, *Larix americana* Michx. Intermixed with this is to be found a considerable quantity of black spruce, *Picea nigra* Link.

Of course the bordering edges are of typical hard-wood swamp, where maples, ashes and elms predominate. The north and west shores directly contiguous to Mille Lacs lake are high and abundantly covered with groves of maple, elm and oak. Quite often scattered clumps of the hackberry, *Celtis occidentalis* L., are found.

The major part of the Mille Lacs Indian reservation is covered with a luxuriant and valuable growth of pine, mostly *Pinus strobus* L. and *Pinus resinosa* Ait. South of this to a line a few miles north of Princeton the country is covered with a thick growth of mixed timber. This formerly contained considerable pine, but owing to the demands of civilization it has disappeared. Intermixed with this was a valuable and interesting growth of hard-wood timber, consisting mostly of oak and elm. In many places this has been cut off and the characteristic plants of burnt wood-lands have become introduced.

South of Princeton sand dunes and oak openings prevail. Here almost the only trees for miles around are *Quercus macrocarpa* Michx. and *Quercus velutina* Lam.

Heretofore there has been, to my knowledge, almost no collecting and identification of material in this valley, which seems to present comparatively so little of the effect which agricultural development always has on a given area. So we find very few cosmopolitan species, and these are found contiguous to the railroad and near the few and scattered farm houses and claim shanties.

Very interesting are the orchids found in the swamps and damp woods. Most frequent to appear is *Habenaria broctrata* R. Br. This plant, while never occurring abundantly in any one place, nevertheless is found throughout the whole valley wherever anything approaching the condition of hardwood swamps is found. *Habenaria tridentata* Hook. and *Habenaria obtusata* Rich. were found sparingly in a little swamp near Nicholas, Aitkin county. *Corallorhiza corallorhiza* (L) Karst., *Cypripedium acaule* Ait. and *Cypripedium arietinum* R. Br. occur more frequently. *Achroanthes unifolia* (Mx.) Raf. is another rare orchid found growing luxuriantly in a swampy opening near Vineland, Crow Wing county. In all specimens examined, last mentioned species, the pollinia occur singly in each cell.

Petorites palmata (Hook) Gray was found but it is local in its occurrence. It prefers low, damp situations on the edges of swamps and is frequently found in open groves of poplar saplings.

Gilia linearis (Nutt) Gray is abundant along the sandy beach of Mille Lacs lake, especially on the north and west shores.

This plant is very local in its range in Minnesota. Dr. Sandberg found it at Red Wing in 1885. Aside from this the Mille Lacs locality is the only one that is definitely known for this plant in the state. From these two eastern Minnesota localities it is reported westward to the Pacific.

Physolis grandiflora Hook., a distinctive plant of the

Saskatchewan and Lake Superior basins, reaches its southernmost limit along the western edge of Mille Lacs lake. It is found abundantly in the neighborhood of the aboriginal earthworks in the northwestern corner of the Indian reservation.

Oenothera albicaulis Nutt. reaches the easternmost limit of its range in central Mille Lacs county. It is found frequently on burnt woodlands and has doubtless been introduced through the agency of the railroad.

Oenothera rhombipetela Nutt. also seems to have its northernmost limit in Anoka and southern Mille Lacs counties. In Minnesota it is characteristically a sand-dune plant.

Pentstemon grandiflorus Nutt., *Pentstemon gracilis* Nutt. and *Penstemon pubescens* Solander are frequent in the oak openings of the southern portion of the valley.

A remarkable form, closely resembling *Pentstemon albidus* Nutt., but having the open thyrse and, to a certain extent, the bearded lip of *Penstemon pubescens* Solander., was found on the sandy shores of an old lake bed west of Princeton. The constant discovery of peculiar forms of the species of *Penstemon* renders the genus extremely difficult to study.

Phegopteris calcarea Fée is an interesting fern which has so far only Minnesota and Iowa for its American localities. In Iowa it was found near Decorah by Mr. E. W. D. Holway. In Minnesota it has hitherto only been reported by Miss Ellen Cathcart from the banks of the St. Louis river. I have found three new localities for it in the Rum river valley. It was first found on the shady banks of Farm island, in Farm Island lake, about nine miles south of Aitkin. Later in the season I found it growing in abundance on Robinson's island, in Mille Lacs lake, and on the shady banks of Bordin's creek, near Garrison, Crow Wing county. It prefers shady locations on the north side of high banks.

Its near congener, *Phegopteris dryopteris* Fée. was also found abundantly on Robinson's island and on Bassett's point, near Vineland, Mille Lacs county.

The enumeration of all the peculiar and interesting plants found would be of value, but it is rather my object to point out the prolific character of this narrow strip. This is due, of course, to the diversity of conditions for plant sustenance.

Then, too, a study of the plants introduced through the agency of the railroad would be of interest. But in a section so near to the original in nature a notice of the abundance of peculiar Saprophytic plants must be taken. Everywhere in the different timbered localities, in the swamps and over the burnt woodlands Agaricinæ and other fleshy fungi were especially noticeable.

The flora of the "Thousand lakes" must also be noted, and it is well to notice that even in the counties most thickly studded with lakes, each has its characteristic alga.

November 13, 1892.

[*Paper F.*]

THE FAUNA OF THE MAGNESIAN SERIES.

DESCRIPTIONS OF FOSSILS.

F. W. Sardeson.[*]

The object in presenting the following notes on the faunal characters of the Magnesian series is to establish a systematic table as a basis for the rational division of the formations of the series. A mere compilation of species already described and referred to this series would seem to prove the existence of two faunas, one for the "Lower Magnesian" and another for the "Potsdam" or "Lower Sandstone" of the Upper Mississippi basin. But no such two faunas exist. Each is a confusion of different faunas. There were also very few species known and these of very rare occurrence. In searching for these old species—for all data had to be verified—several new species have been discovered.

All fossils collected have been referred with the greatest care to their proper division of the "Lower Magnesian" (Owen), viz.:

1. Shakopee dolomite.
2. New Richmond sandstone.
3. Oneota dolomite.

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[*] Partially revised November 18, 1895.

Or to those of the "Potsdam:"

4. Jordan (Madison) sandstone.
5. Saint Lawrence (Mendota) formation.
6. "Dresbach" or "Saint Croix" sandstone and the undivided series beneath it.

Only numbers 1 to 5, i. e., the Magnesian series (Hall and Sardeson), are fully included in this discussion.

Of these five formations it is found that the Shakopee has a fauna consisting of species of mollusca, all of which are peculiar to that formation. The New Richmond sandstone has so far yielded no fossils. The Oneota, Jordan and Saint Lawrence, on the contrary, are not only fossiliferous, but the species of each are in part the same as those of the other two. The fauna of the Oneota dolomite consists mainly of Gasteropoda, Cephalopoda, a few brachiopoda, and no others except one fragment of a trilobite (*Asaphus*). The Jordan fauna resembles that of the Oneota, but embraces also trilobites like the Saint Lawrence. The last named has yielded but one molluscan species as yet, and several Brachiopoda besides Trilobita. This account may be enlarged in future.

Nearly all the Trilobita are omitted here, both because they aid only in comparing the Jordan and Saint Lawrence with each other and with underlying strata, all of which have been heretofore united ("Potsdam"), but also because the species have been described from fragments and rare occurrences, most of which the author has not yet had the opportunity to verify. These will form a problem for the future. The Mollusca and Molluscoidea are presented below, and from a study of them it has been concluded that the Shakopee is faunally separate from the Saint Peter sandstone above and to a less degree also, from the Oneota below. The New Richmond sandstone maintains uncertain relations between them. With the Oneota are united the Jordan and Saint Lawrence, which last contains a fauna distinct from the next known fauna below it, i. e., that with *Obolella polita* Hall, *Lingula ampla* Owen, *Hyolithes primordialis* Hall.

The Mollusca, like the Trilobita, occur as casts. In the Oneota particularly, the casts have sometimes filled with chert and are locally more abundant for that reason. A dolomitized shell rarely occurs. The Brachiopoda more often have their shells preserved and can thus, like the silicified casts of molluscs, be found even where the reduction of the strata has obliterated the hollow casts. Such obliteration is often noted in the Shakopee and Oneota, and very frequently in the Jordan and Saint Lawrence.

The following table shows the distribution in vertical range of the species collected, and following it are notes upon and decscriptions of the same.

TABLE OF FOSSILS IDENTIFIED FROM THE MAGNESIAN SERIES.	*St. Lawrence.*	*Jordan.*	*Oneota.*	*New Richmond*	*Shakopee.*
Asaphus sp.			*		
Dikelocephalus minnesotensis Owen	*				
Lingula aurora Hall	*				
Lingula dolata n. sp.			*		
Lingula mosia Hall	*		*		
Lingula winona Hall	*				
Orthis (Billingsella) pepina Hall	*	*	*		
Bellerophon antiquatus Whitfield		*			
Euomphalus winonensis n. sp.			*		
Helicotoma (?) peccatonica n. sp.					*
Holopea obesa Whitfield			*		
Metoptoma barabuensis Whitfield		*			
Murchisonia argylensis n. sp.					*
Murchisonia putilla n. sp.		*	*		
Ophileta alturensis n. sp.		*	*		
Pleurotamaria sweeti (Whitfield)		*			
Raphistoma leisomellum n. sp.			*		
Raphistoma lewistonense n. sp.					*
Raphistoma minnesotense Owen	*	*	*		
Raphistoma oweni n. sp.			*		
Raphistoma ruidum n. sp.					*
Straparollus intralobatus n. sp.			*		
Subulites exactus n. sp.					*
Tryblidium (?) repertum n. sp.					*
Ascoceras gibberosum n. sp.			*		
Cyrtoceras dresbachense n. sp.			*		
Cyrtoceras winonicum n. sp.			*		
Endoceras consuetum n. sp.					*
Piloceras corniculum n. sp.			*		

DESCRIPTIONS OF SPECIES.

Dikelocephalus minnesotensis Owen.

Dikelocephalus minnesotensis Owen, Report of Geological Survey of Wisconsin, Iowa and Minnesota, p. 574, Tab. I, figures 1, 2, 10; and Tab. I, A, figures 3 and 6.

Dikelocephalus minnesotensis Hall, 16th Annual Report New York State Museum of Natural History, p. 138, pl. XI, figures 1, 3 and 4.

This species is found in the Saint Lawrence dolomite at Osceola, Wisconsin, and Hokah, Minnesota, and intermediate. At the last-named place specimens were taken out five feet below the firm stratum of dolomite or about 35 or 40 feet below the top of the Saint Lawrence formation.

Lingula aurora Hall.

Lingula aurora Hall, Annual Geological Report of Wisconsin, 1861, and 16th Annual Report, New York State Museum of Natural History, p. 126, pl. VI, figures 4 and 5, 1863.

Associated with *Dikelocephalus minnesotensis* Owen in the Saint Lawrence formation at Osceola, Wisconsin, Otisville, Minnesota, along the St. Croix river and in exposures along the Mississippi river in Minnesota and Wisconsin are three abundant species of lingula, of which this one is the largest. It is easily recognized by the surface ornamentation of the shell.

Lingula dolata n. sp.

Plate VI, figure 12.

Shell of medium size, ovate, length not much exceeding the breadth; slopes from the beak nearly straight; lateral and anterior margins uniformly rounded; beak probably acute. The convexity of the shell is moderate and seems to have been greatest towards the beaks. The surface is shining but marked by numerous fine, irregular concentric lines which run out on either side along the slopes from the beak.

From the Oneota dolomite near Stillwater, Minnesota.

Lingula mosia Hall.

Lingula mosia Hall, 16th Report New York State Museum of Natural History, p. 126, pl. VI, figures 1 to 3, 1863.

This species is referred by James Hall to the same formation as *Dikelocephalus minnesotensis* Owen. Very good shells agreeing in every respect with the figures 1, 2 and 3 and with the original description have been found at several exposures of the Saint Lawrence formation. Some of them retain the glossy surface of the shell and the coarse concentric striations. Other specimens, not distinguishable from these, occur in the middle or upper portions of the Oneota along the Saint Croix river. But these, as preserved, retain a stronger convexity of the shell.

Lingula winona Hall.

Lingula winona Hall, 16th Annual Report New York Museum of Natural History, p. 126, pl. VI, fig. 9, 1863.

This species was described by James Hall from specimens obtained at Lansing, Iowa, "occurring more than two hundred fest below the Lower Magnesian limestone and near the middle of the Potsdam sandstone." The specimens here identified with it occur in numbers with other Lingula in the Saint Lawrence formation near Osceola, Wisconsin, and other places along the Saint Croix river. They have the sub-quadrate outline, a thick shell and show a deep pedicel groove.

Orthis (*Billingsella*) *pepina* Hall.

Orthis pepina Hall, 16th Annual Report New York State Museum of Natural History, p. 134, pl. VI, figs. 23 to 27, 1863.

Orthis pepina Whitfield, Geology of Wisconsin, vol. IV, p. 170, pl. I, figs. 4 and 5, 1882.

Orthis (*Bilingsella*) *pepina* Hall (1892), Palæontology of New York, vol. VIII, pt. I, p. 230, pl. VII, a, figs. 1-9.

This species is found at Osceola, Wisconsin, and vicinity in the Jordan sandstone and it occurs also in the Oneota dolomite a few miles further south, near Stillwater, Minnesota. It occurs also in the Saint Lawrence formation.

Bellerophon antiquatus Whitfield.

Bellerophon antiquatus Whitfield, Annual Report for 1877, Geological Survey of Wisconsin, p. 52; and Geology of Wisconsin, vol. IV, p. 176, pl. I, figs. 13 and 14, 1882.

Described by Mr. Whitfield from the "soft friable sandstone of the Potsdam group at Osceola Mills, Wisconsin." It has not yet been found on the Minnesota side of the Saint Croix river, although specimens have been found in the Jordan sandstone at the locality cited.

Euomphalus winonensis n. sp.

Plate VI, figure 1.

Shell of more than two and one-half volutions; rapidly expanding and in contact for about two volutions. The apex and flattened surface are nearly in the same plane. The suture is deep and the umbilicus wide. Aperature circular except for a deep notch on the upper outer margin, the successive stages of which have produced an angular keel, a flattened upper surface to the coil and a slightly concave band just beneath the keel. On the volutions that are in contact the upper inner surfaces are concave or of reduced convexity. The surface is marked by strong, irregular lines of growth, which curve obliquely back on either side of the keel, forming an angle at the acute edge of the carina. The shell was apparently very thin, and the apical portion of it was either filled solid or crossed by strongly concave septa for nearly one and one-half volutions on the largest specimen found.

From the Oneota dolomite near Dresbach, Winona county, and near Red Wing, Goodhue county, Minnesota, and at Blanchardville, La Fayette county, Wisconsin.

Helicotoma (?) *peccatonica* n. sp.

Plate V, figures 1 and 2.

Known casts of the shell are of about three volutions. These are strong and evenly convex on the inner and lower surface, while the outer surface is flattened and is bounded above and below by angular carinæ, of which the upper may prove to be of the nature of a band. The upper surface of each volution is divided into an outer concave surface, a convex median ridge and an inner flattened slope that joins the suture, and each volution is impressed on the upper inner side by the preceding one.

The coil is turbinate with an apical angle of about 130°, with a wide umbilicus and deep sutures. The aperture is circular in general outline. The growth lines are not distinctly preserved.

From the Shakopee dolomite in the Peccatonica river valley, near Argyle, Wisconsin.

Holopea obesa Whitfield.

Plate V, figure 19.

Holopea obesa Whitfield, Geology of Wisconsin, vol. IV, p. 348, pl. XXVII, fig.11, 1882.

Shell large, of five strongly convex volutions, and with an apical angle of 90° or less. Each volution is indented by the preceding one, but otherwise the upper surface is strongly convex. The lower portion of each volution is rounded, while the outer surface is less and the umbilical surface still less convex. The sutures are deep. No surface marks or growth lines are visible on the quartz casts that have been found.

Found among fossils from the upper portion of Oneota formation at Dresbach and Altura, Minnesota, and Blanchardville, Wisconsin.

Metoptoma barabuensis Whitf.

Metoptoma barabuensis Whitf,, Geology of Wisconsin, vol. IV, p. 195, pl. III, figs. 16 and 17.

One specimen, a little smaller but otherwise not distinguishable from this species as figured and described, comes from the Jordan sandstone at Osceola, Wisconsin, where it is associated with *Pleurotomaria sweetii*, Whitf., etc.

Murchisonia argylensis n. sp.

Plate V, figures 11 and 12

Shell of many volutions (about fifteen), closely coiled; apical angle 160°. The columella is slender and imperforate, the sutures deep and the outer surface of each coil flattened. Casts of the interior are more uniformly convex and end acutely about one-fourth the distance from the apex.

The aperture is vertically sub-qnadrate, and there are indications that it was deeply notched on the outer margin. Along the coil there appear two minute longitudinal grooves, dividing the outer surface into three nearly equal areas, the middle one of which is probably the band.

Figure 11, plate V, is a sketch of a specimen showing the cavity left by a shell, the apical third being entirely empty, the middle portion enclosing a cast of the interior, and the lower volutions containing the replaced shell, which is broken open and shows the columella.

From near Argyle, Wisconsin, in the Shakopee dolomite. Found also at Shakopee and Cannon Falls, Minnesota, in the Shakopee dolomite.

Murchisonia putilla n. sp.

Plate V, figures 5 and 6.

The specimens of this species are small turreted coils of six to eight or more volutions with an apical angle of 45°. The outer surface is marked by a strong angular carina a little below the middle height of each volution, and a second and third subangular carinia divide the outer from the upper and lower surfaces respectively. The lower surface of the body whorl is moderately convex and is joined with the inner surface somewhat abruptly. There is a large perforated columella formed by the vertical, moderately convex inner side of the volutions. The upper side of each volution coincides in form with the base of the preceding one, so that the suture is close, and in fact it is formed by the contact of two carinæ.

Previous to fossilization or silicification several of the specimens have been indented deeply by the sharp crushing processes of some animal. These wounds, besides being peculiar tooth marks in appearance, seem to show distinctly from their form and from the compression of the shells that the latter yielded by bending or folding and not by fracture. One shell had been also partly uncoiled.

Found in the top of the Oneota dolomite near Dresbach, Winona county, and at Stillwater, Minnesota, and Blanchardville, Wisconsin. Also from the Jordan sandstone near Rapidan, Blue Earth county, Minnesota.

Ophileta alturensis n. sp.

Plate V, figures 3 and 4.

Shell a dextral coil of six or more slowly expanding volutions, the spire of which does not rise above the carina of the body whorl. The volutions are strongly convex below, but are flat or concave in the umbilicus, and straightened or slightly concave below the carina on the outer side. This high, acute carina on the upper outer angle gives a concave upper surface, which, however, curved down to the suture on the inner side. The umbilicus is very wide.

The growth lines are coarse and indistinct. They curve obliquely back from the sutures to the carina for a distance equal to the width of the upper surface of the volution, forward again down to the base and thence with a back and forward curve across the umbilical surface.

Found in the Oneota dolomite near Dresbach, at Altura and Mankato, Minnesota, near the top of the formatiom. Also at Caledonia, Houston county.

Plurotomaria sweeti Whitfield.

Holopea sweeti Whitfield, Geology of Wisconsin, vol. IV, p. 174, pl. X, fig. 3, 1882.

Casts of this shell occur at Osceola Mills, Wisconsin, in the Jordan sandstone. They agree with Mr. Whitfield's description and the figure of his specimen except that the growth lines on casts of the exterior show that the aperture had a very deep sinus which has left on some an elevated, broadly rounded band just below the middle of the outer surface of the last volution. This species is of the same type as the *Pleurotomaria aiens* Sar., from the Saint Peter sandstone.

Raphistoma leiosomellum n. sp.

Plate V, figures 7 and 8.

The shell of this species, as shown by the quartz casts found was small and consisted of about four rapidly increasing volutions, which embrace in such a manner as to form a lenticular coil. Each volution conceals about one-half of the surface of the preceding one. The suture is channelled, the periphery is marked by a rounded somewhat swollen band, and the umbilicus, which is about one-fourth the entire width of the coil, is abrupt and ascends by degrees quite to the apex. The surface is smooth and nearly equally convex above and below.

From the upper portion of the Oneota dolomite near Dresbach, at Altura, Winona county, and near Caledonia, Houston county, Minnesota.

Raphistoma lewistonense n. sp.

Plate V, figures 9 and 10.

The only specimen of this species found is a hollow cast of the exterior of a shell, and from this rubber casts have been taken. These show a coil of about four volutions which are flat above and strongly ventricose below. The suture of each volution falls a little below the periphery of the preceding volution. The umbilicus is about one-third the entire width and ascended probably to the apex. The varices of growth appear to run obliquely back from the sutures to the periphery and thence directly down and into the umbilicus.

Found in the Oneota dolomite near Lewiston, Winona county, Minnesota. Identified also at Shakopee and Cannon Falls, Minnesota.

Raphistoma minnesotenses Owen.

Plate V, figures 15, 16 and 17.

Straparollus (*Euomphalus*) *minnesotensis* Owen (1852), Report Geological Survey of Wisconsin, Iowa and Minnesota, p. 581, tab. II, figs. 12 and 13.

Euomphalus vaticinus H., 1863, 18th Rep. N. York Mus. Nat. Hist. p., 136.

Shell large, of *eight* or *nine* slender whorls, which gradually expand and remain in contact throughout. The apical angle is very obtuse at first but gradually decreases to about 120° as the coil expands, giving a somewhat lenticular outline. This character also varies in specimens of the same size; umbilicus very wide. The volutions are strongly convex below and above, but gently concave along the strong angular carina upon the outer side and strongly concave along the same above. The carina rises above the sutures on the internal casts, but not so strongly on the exterior of the shells. The aperture is subquadrate and deeply notched.

This is an abundant species in the upper strata of the Oneota, but is found only as imperfect specimens, the smaller ones of which are easily mistaken for a distinct species. There are, however, no others with which this one could be confused known to occur in the same formation.

Found at Dresbach, Winona county, near Red Wing, Goodhue county, at Mankato and other places in Minnesota, and Blanchardville, Wisconsin. Also found in the Jordan sandstone near Rapidan, Blue Earth county, Minnesota. At Red Wing also in the Saint Lawrence.

Raphistoma oweni n. sp.

Plate V, figure 18.

Shell of ten or twelve very slender whorls in close contact, but not always uniformly coiled. The apical angle of the shell varies a little from 140°. The umbilicus is very wide. A transverse section of each volution presents a quadralateral figure which is approximately a parallelogram with the outer angle acute, equal to about 75°. Upon the outer angle or carina is a small band which on the spire rises a little above the sutures. The upper surface of a volution has a depression along the carina, is nearly flat over most of the surface, but strongly rounded on top into the suture. Below, the surface is flattened or gently concave on the outer and umbilical areas, but has a strongly convex or subangular area between these two. In the umbilicus each volution leaves exposed to view a part of the outer surface of the preceding one, while on the apical surface the sutures are close or only slightly channelled. The surface is indistinctly striated on internal casts by transverse lines which on the upper surface curve back at an angle of about 45°, from the suture to the carina. The irregularity in coiling does not seem to be due to distortion.

From the Oneota dolomite of the Magnesian series in the Saint Croix valley, above Stillwater, Minnesota.

The first specimens seen of this species were collected by Mr. A. D. Meeds, of the University of Minnesota. The name is given in honor of Dr. David Dale Owen.

Raphistoma ruidum n. sp.

Plate V, figures 13 and 14.

Shell of four or more volutions rising in a low spire. The volutions are convex above with a narrow concave area along the periphery. Below, the surface of each is moderately convex along the periphery and strongly convex next the umbilicus, but gently concave for the greater distance between these two areas. The umbilical surface is flattened also and is the shortest of the four sides of the subquadrate figure presented by a cross section. The outer side next the umbilicus is the longest, and the sides are about in the relation of 5, 6, 7 and 8. The umbilicus is wide and deep.

A cast of the interior shows that the shell was ornamented by sharp elevated striæ of growth. These are evident also on casts of the interior, and curve obliquely back for a distance greater than one-eighth of a volution and suddenly out in a reversed curve near the acute edge of the volution.

Specimens of this species were found near Argyle, Wisconsin, in the Shakopee formation, and at Shakopee, Minnesota, in the quarry at that place. Also near Cannon Falls, in the Shakopee formation.

Straparollus intralobatus n. sp.

Plate V, figure 20.

Coil small, of three to four volutions, in the same plane, or nearly so, and in close contact. The aperture is transversely oval except where indented on the inner margin by the penultimate volution. The surface of the cast is marked by growth lines that are rather variable and indefinite and run a little backwards near the dorsal side.

Found at Altura, Winona county, above the middle of the Oneota dolomite.

Subulites exactus n. sp.

Plate VI, figure 14.

Casts of the interior of shells of this species show a long, slender spiral of twelve or more whorls in all. The accompanying figure shows a cast of probably the fifth to eighth whorls. The whorls are gently convex on the outer surface, but are more strongly rounded near the sutures, which are wide and deep on the casts and appear to have been equally strong on the exterior of the shell. Surface marks can not be detected and the form of the aperture is not well shown but must have been elongate, rounded very narrowly above and more broadly below, and with the centers of the inner and outer lips somewhat increased in convexity.

Found at Shakopee, Minnesota, in the Shakopee dolomite, and in the same formation near Cannon Falls, Minnesota.

Tryblidium repertum n. sp.

Plate V, figures 21 and 22.

Shell small, low, with the apex towards the posterior and directed backward. Aperture oval, about 11 mm. in longitudinal and 9 mm. in transverse diameter. Apical elevation of the shell 6 or 7 mm. From the apex the surface curves gently down to the anterior margin, while on the posterior and along the lateral portions the surface is concave. There are some slight indications of concentric undulations, but other characters are not visible on the casts of oölitic dolomite.

One specimen referred to this species has a much higher apex and a proportionally narrower aperture supposed to have been caused by contortion previous to its deposition in the stratum, but it is in every respect symmetrical.

From the Shakopee dolomite formation near Argyle, Wisconsin.

Ascoceras gibberosum n. sp.

Plate VI, figures 8, 9 and 10.

All that is known of this species are casts of the septate portion, one of which is sketched. The specimens do not show conclusively that they represent the hollow chambers extending along the chamber of habitation, but presumably that is their nature. The septa, eight or nine in number, are not regularly equidistant, and grow one above and over the other in the dorsal (or ventral) portion of the shell somewhat irregularly but always overlapping the last above and on the sides, but slightly underlapping below. This last character gives some indication that there may have been also a regular system of septa in the base of the shell. The entire shell must have been short and small, with the aperture contracted and oblong ovate dorsoventrally.

From the Oneota dolomite at Dresbach, Minnesota.

Cyrtoceras dresbachense n. sp.

Plate VI, figure 4.

Shell small, expanding somewhat rapidly, and curved. Transverse section ovate, with the apex on the dorsal side. The septa are numerous and arch rather strongly forward on the outer, and also on the inner, surface. The siphuncle is small and is situated near the inner side of the shell. The chamber of habitation and the surface of the shell are not known. Septa arched dorso-ventrally, otherwise nearly flat.

From the Oneota dolamite near Dresbach, Minnesota.

Cyrtoceras (?) *winonicum* n. sp.

Plate VI, figures 2 and 3.

Shell small, very slowly expanding, straight or slightly curved. The septa ate strongly concave in dorso-ventral direction, very gently so across from side to side, and the sutures curve forward above and below and backward across the sides. The depth of the chamber of habitation is not known. The septa are very close together, eight or ten falling in a length equal to the transverse diameter. The siphuncle is small, marginal and flattened next the outer wall. Transver section of the shell oval. The surface of the shell is not preserved on any of the specimens, but the casts are smooth.

Found near Dresbach, Winona county, Minnesota, among other fossils from the Oneota dolomite.

Endoceras consuetum n. sp.

Plate VI, figure 11.

The shell long, straight, slowly expanding. The chamber of habitation is deep, about two and one-half to three times as deep as high. Transverse section vertically suboval, with the outline of the siphuncle circular and about one half as great in diameter as the shell. Siphuncle close to the ventral side. The septa are close together and concave. The sutures arch forward slightly near the dorsum and apparently backward on the ventral side, and in general they are oblique to the longitudinal axis. The shell was very thin, and on the cast leaves indistinct undulating growth lines along the body portion, parallel to the sutures of the septate portion. There is a concave band on the surface of the first septum on the specimen, near the siphuncle, but which may be due partly to distortion.

From near the top of the Shakopee at the crossing of the Chicago, Milwaukee and Saint Paul and the Illinois Central railways, ten miles west of Monroe, Wisconsin, and one-half mile below Pickett station.

Piloceras corniculum n. sp.

Plate VI, figures 5, 6 and 7.

The siphuncles of four shells have been found as quartz casts. These show a rapidly, uniformly expanding shell of small size. The sutures on the siphuncle are distant about one-fourth the vertical diameter of the same, but on different specimens have a varying direction. The concavity of the septa appears to decrease as the shell increases and their apices are not uniformly directed on different specimens, and in one case the apex is toward one side. A transverse section of the siphuncle is vertically oval, on all alike. A third specimen, not figured, retains a portion of the outer surface and septa, and indicates the position of the siphuncle as close to the dorsal (concave) side and its diameter about one-half that of the shell. Surface of the shell probably smooth.

Without an extensive series of specimens it is quite impracticable to determine whether one or two species are here described, but the great variation of some characters seen in the specimens at hand seems to indicate strong variability rather than specific difference.

From the Oneota dolomite, near Dresbach, Winona county, Minnesota.

Besides the above list of fossils Professor Calvin* has described several species, viz.:

Metoptoma alta Whitf.
Tryblidium sp.
Straparollus claytonensis Calvin.
Straparollus pristoformis Calvin.
Raphistoma pepinense Meek.
Raphistoma multivolvatum Calvin.
Raphistoma paucivolatum Calvin.
Holopea turgida Hall.
Murchisonia sp.
Orthoceras primigenium Vanuxem.
Cyrtoceras luthei Calvin.

from the Lower Magnesian of northeastern Iowa. But his descriptions leave us in doubt wheather they are Oneota or Shakopee or both. I could not clearly recognize in the short descriptions, which are not accompanied by figures, any of the species described by me. The Shakopee and Oneota were examined near McGregor, Iowa, and although I found no fossils, still fossils ought to be found there in both formations. These two formations present their normal stratigraphic and lithologic character in Iowa. Fossils from southeastern Minnesota and southwestern Wisconsin, which are on opposite sides of northeastern Iowa, present the same faunas in each of the formations, Shakopee and Oneota. In Iowa they should also occur. *Raphistoma multivolvatum* Calvin may be *R. minnesotense* (Owen). His other two species of *Raphistoma* one can only reject. His *Holopea turgida* H. may be *H. obesa* Whitf. The others seem to be some that I have not found.

The Shakopee fauna is most like that of the "Upper Calciferous." That of the Oneota, Jordan and Saint Lawrence is likewise comparable to the Lower Calciferous of New York. It, in fact, resembles the Calciferous far more than it does the peculiar fauna described by Whitfield† from the Baraboo district of Wisconsin which has been supposed to be "Lower Magnesian." These are:

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*Amer. Geol., vol. 10, pp. 144:148 (1892).
†Geol. Wisconsin, vol. IV, p. 194.

Leptæena barabuensis Whitf.
Metoptoma barabuensis Whitf.
Metoptoma recurva Whitf.
Metoptoma similis Whitf.
Metoptoma retrorsa Whitf.
Scævogyra swezeyi Whitf.
Scævogyra elevata Whitf.
Scævogyra obliqua Whitf.

I mention also:

Euomphalus strongi Whitf.
Ophileta (*Raphistoma*) *primordialis* Wihchl.
Palæacma irvingi Whitf.

Of the above *Raphistoma primordiale* Winchl. may be again *R. minnesotense* (Owen)—Oneota to St. Lawrence. One other—*Metoptoma barabuensis* Whitf. I think is represented by one specimen from the Jordan sandstone at Osceola, Wisconsin. It is not improbable that the whole list contains really the missing Gasteropoda of the Saint Lawrence formation. If so then this formation is wider from the Oneota than I think it to be. Still this fauna may belong to an older formation, preceding the Saint Lawrence.

Regarding the biological side of the question of the relations of these fossils, it must be observed that to associate, for example the species *Raphistoma leisomellum*, *R. lewistonense*, *R. minnesotense*, *R. oweni* is to extend the limits of the genus. These with *Ophileta alturensis* form an interesting series of forms which, however, is best not further enlarged upon here. There may in the future be some interesting discoveries, for there occur here and there "fucoids" and other structures like fig. 13, pl. 6, from the Shakopee near Pickett Station, Wisconsin, that show the former existence of still other fossils than those thus far found.

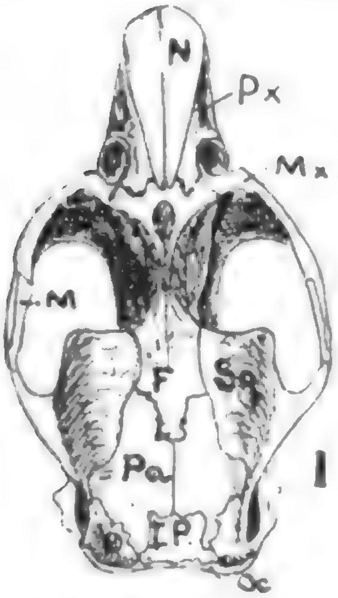
December 6, 1892.

PLATE I

All similar views are made on the same scale, irrespective of actual size, and as nearly as possible in exactly similar positions so as to facilitate direct comparison. The lettering is the same for all the skulls, and is the initial letter or letters of the bones referred to: N, nasal; Px, pre maxillary; Mx, maxillary; M, mólar; Fr, frontal; Sq, squamosal; Pa, parietal; Ip, inter-parietal; Oc, occipital.

Fig. 1. Muskrat; natural size. Fig. 2. Beaver; reduced one-half. Fig. 3. Common Brown Rat; enlarged one-half. Fig. 4. Grey Squirrel; natural size. Fig. 5. Chipmunk; natural size.

Fig. 6. Hinder aspect of tibia and fibula of Pocket-Gogher. Fig. 7. Hinder aspect of tibia and fibula of Beaver; reduced one-half. Fig. 8. Hinder aspect of tibia and fibula of Prairie Dog.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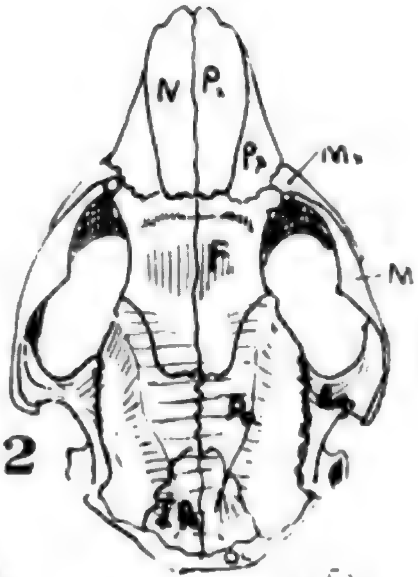
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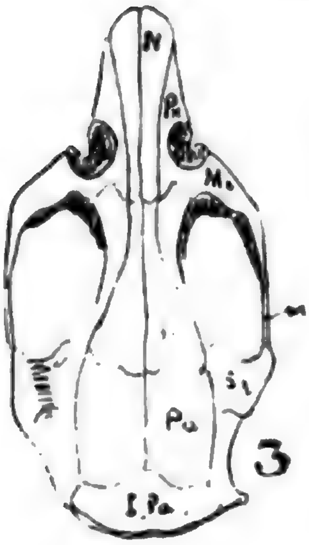
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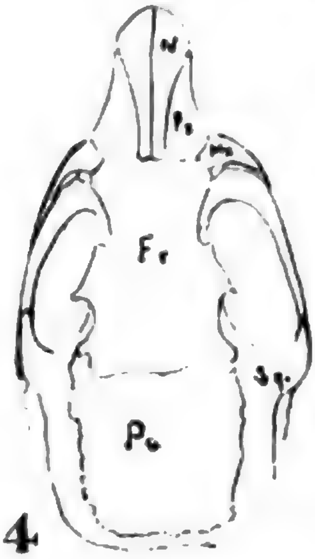
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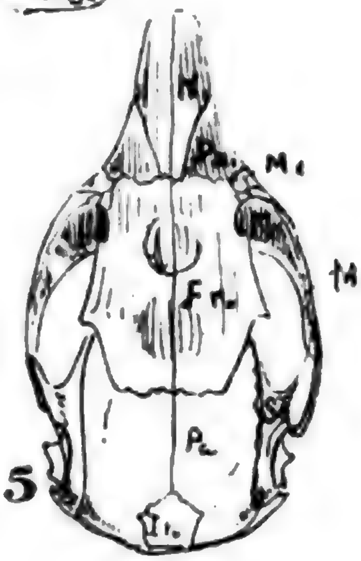
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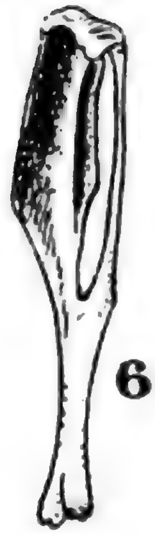

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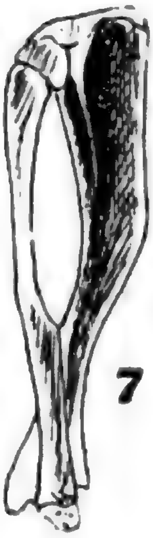

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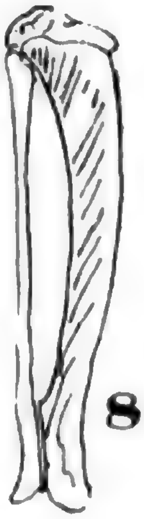

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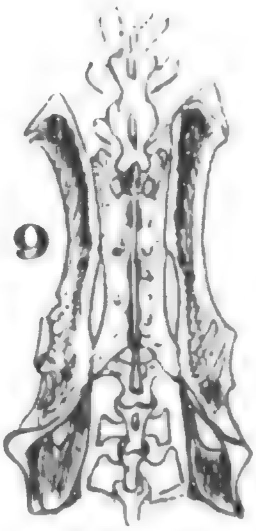

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PLATE II

1, 2 and 3. *Cypricardites* (*Vanuxemia*) *fragosus* n. sp. (1) The right valve of a large specimen. (2) Anterior muscle scar and cardinal teeth of a left valve. (3) The concave cast of the anterior portion of a specimen showing the deep muscle scars, the articulation of the cardinal teeth and a section cutting off the anterior ear and the umbones.

4 and 5. *Cypricardites dignus* n. sp. (4) Right valve of the largest specimen, and (5) left valve of another showing a little variation in form.

6. *Cypricardites* (?) *finitimus* n, sp.

7. *Cypricardites descriptus* n. sp.

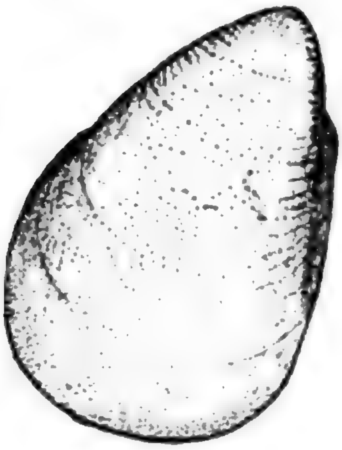
8. *Modiolopsis contigua* n. sp. The upper anterior margin is imperfect.

9. *Modiolopsis affinis* n. sp.

10, 11 and 12. *Modiolopsis gregalis* n. sp. (10) Left valve of an average sized specimen and (11) (12) cross sections of another specimen at one-fourth and two-thirds the distance from the anterior end respectively.

13, 14, 15 and 16. *Modiolopsis litoralis* n. sp. (13) Cast of an average specimen; (14) (15) (16) sections at three-fourths, one-half and one-third the distance from the anterior end.

17. *Modiolopsis senecta* n. sp. Figure of the only specimen seen.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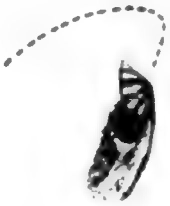
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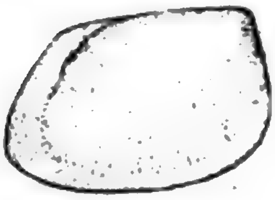
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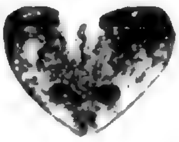
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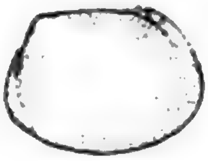
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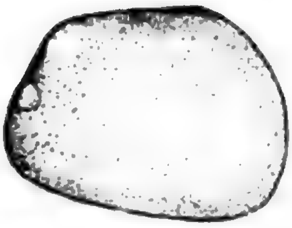
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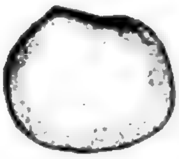
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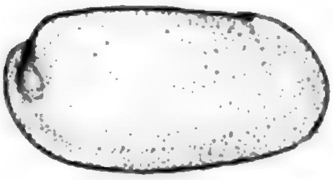
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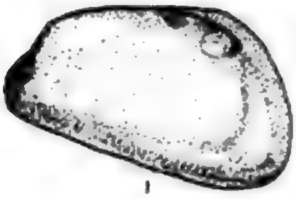
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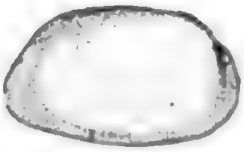
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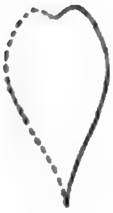
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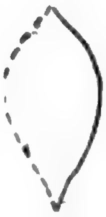
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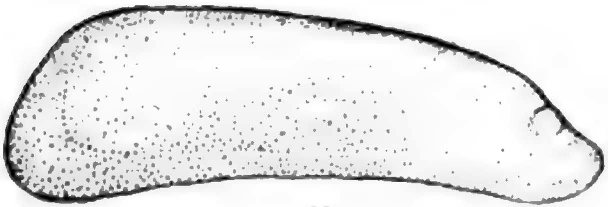
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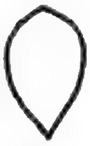
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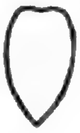
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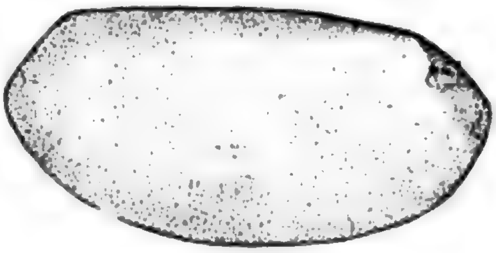
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PLATE III

1 and 2. *Tellinomya absimilis* n. sp.

3. *Tellinomya novicia* n. sp.

4. *Murchisonia gracilis* Hall.

5. *Holopea obliqua* Hall.

6 and 7. *Crania ? reversa* n. sp.

8 and 9. *Ophileta fausta* n. sp. (8) Outer surface of part of the last volution showing the direction of the transverse striæ, and a transverse section of the same specimen. (9) Coil of an imperfect cast.

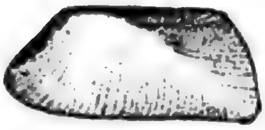
10. *Orthoceras* (?) sp. undet Cast of a fragment of the shell and reconstructed circumference.

11 and 12. *Orthoceras minnesotense* n. sp. (1) View from the left side and (12) from the smaller end of the fragment.

13 and 14. Siphuncle of an *Orthoceras* with a transverse section of the same.

15. Bryozoon (*Ptilodictya ?*).

16 and 17. *Pleurotomaria aiens* n. sp. (16) View showing the deep notch in the aperture and (17) apical view of the same specimen.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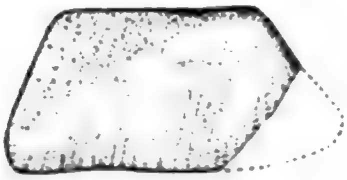
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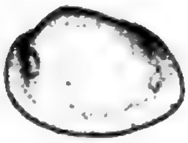
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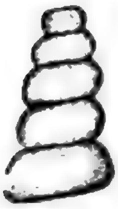
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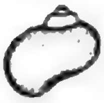
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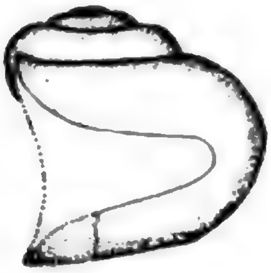
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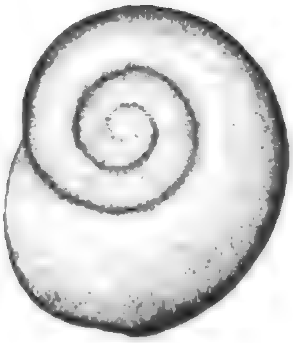
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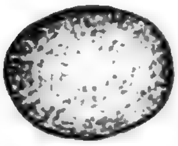
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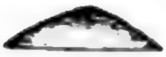
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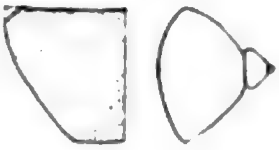
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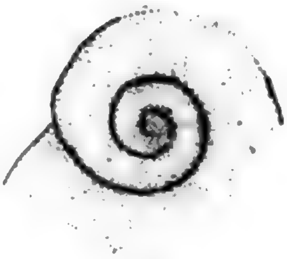
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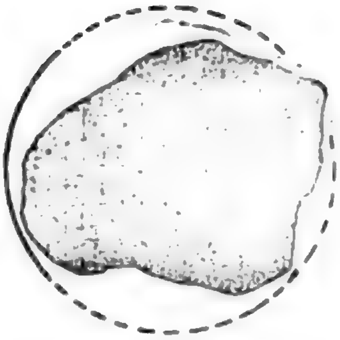
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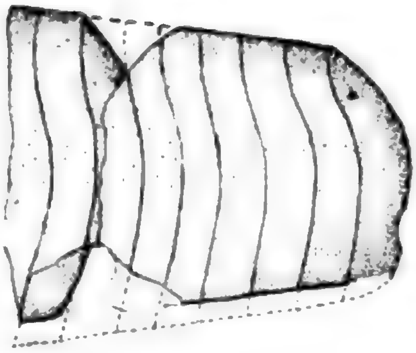
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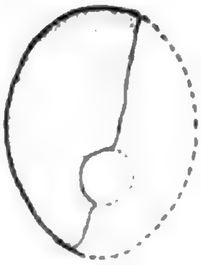
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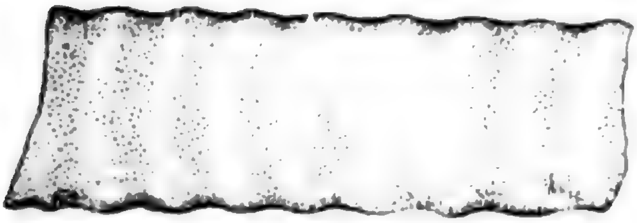
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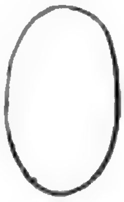
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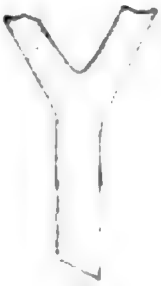
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PLATE IV

1. *Platyceras ? vetulum* n. sp. Apical view.

2 and 3. *Lingula morsii* N. H. Winchell. Outline of a cast (2) and of a shell (3). Both specimens are under the average size.

4. *Orthis* cf. *perveta* Conrad. From an imperfect cast of a ventral valve.

5 and 6. *Raufella fucoida* n. sp.

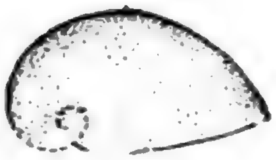
7. *Modiolopsis fountainensis* n. sp. Cast of right valve.

8. *Modiolopsis postica* n. sp.

9. Transition from Saint Peter to Trenton near Fountain.
   - a. Coarse sand and small ferruginous pebbles and argillaceous shale.
   - b. Coarse light yellow sand; 3 feet 6 inches, variable.
   - c. Argilaceous shale, mixed with sand and lime at the top and bottom; 4 feet.
   - d. Coarse sand.
   - e. Firmer ferruginous laminæ.

The formations above and below these strata are characteristic Trenton and Saint Peter.

10. Contact of Shakopee and Saint Peter formations near Pickett Station, Wisconsin.
   - a. Saint Peter.
   - b. Green shale laminæ.
   - c. Dolomite, much folded, exposed in elevation about 20 feet.
   - a b c. Illinois Central railway track.



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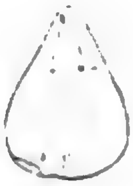

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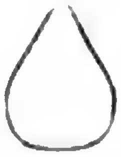

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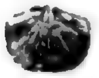

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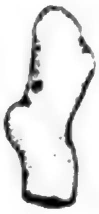

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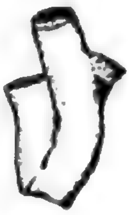

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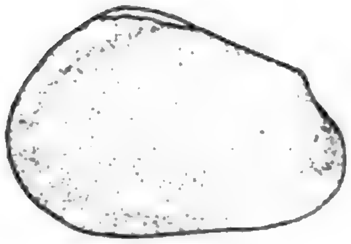

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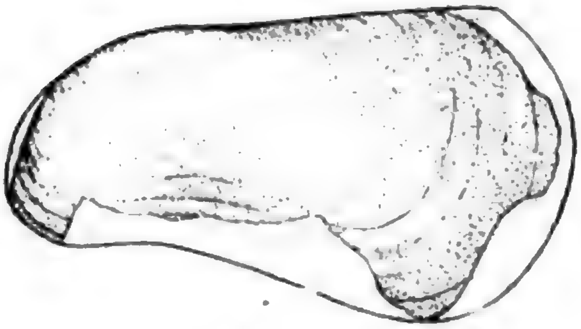

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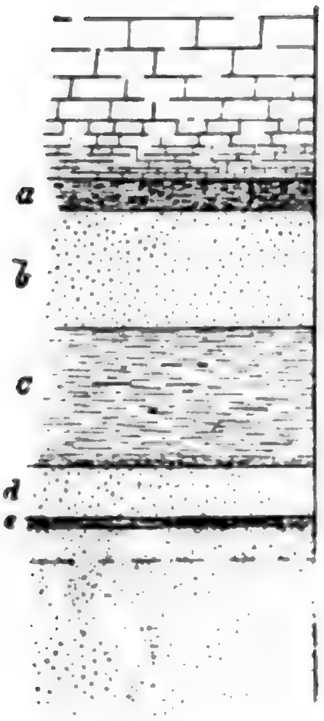

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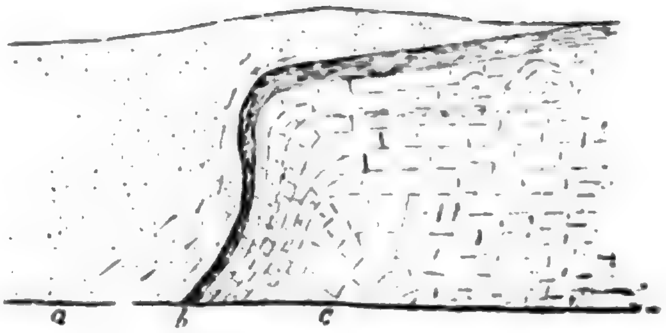

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PLATE V

1 and 2. ***Helicotoma peccatonica*** **n. sp. Apical view and reconstructed transverse section of the coil.**

3 and 4. *Ophileta alturensis* n. sp. Apical view of the coil and cross section of the same.

5 and 6. *Murchisonia putilla* n. sp. Outline of the coil and of the umbilical side of part of a coil with three or four volutions wanting.

7 and 8. *Raphistoma leiosomellum* n. sp. Apical view and an ideal cross section of the coil.

9 and 10. *Raphistoma lewistonense* n. sp. Apical view and cross section of a rubber cast of the exterior.

11 and 12. *Murchisonia argylensis* n. sp. Natural cast of a smaller specimen and an outline of the exterior of a shell obtained on a rubber cast.

13 and 14. *Raphistoma ruidum* n. sp. Apical surface of an interior cast and ideal cross section of the same.

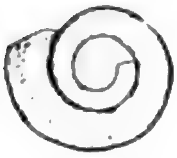
15, 16 and 17. *Raphistoma minnesotense* Owen. (15) Apical view of a few of the first volutions; (16) a reconstructed cross section of an interior cast; and (17) a fragment of about the eighth volution. The upper figure shows the upper surface with growth lines, the next is a transverse section, and the last shows the lower surface.

18. *Raphistoma oweni* n. sp. Apical view of the coil.

19. *Holopea obesa* Whitfield. A broken cast showing in part a transverse section.

20. *Straparollus intralobatus* n. sp. Apical view and outline of the aperture of the shell.

21 and 22. *Tryblidium repertum* n. sp. Apical and side views.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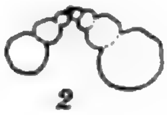
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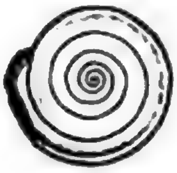
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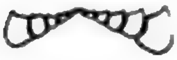
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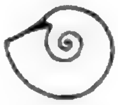
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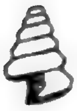
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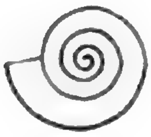
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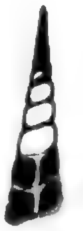
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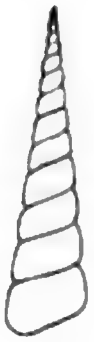
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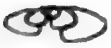
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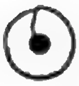
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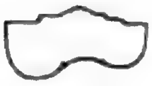
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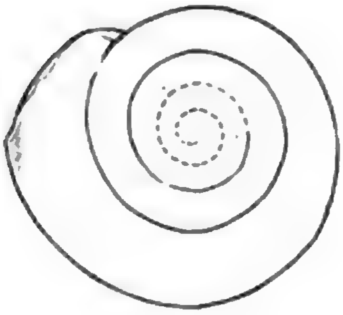
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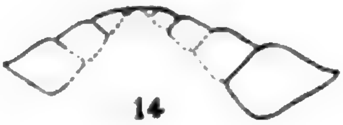
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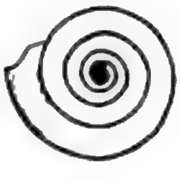
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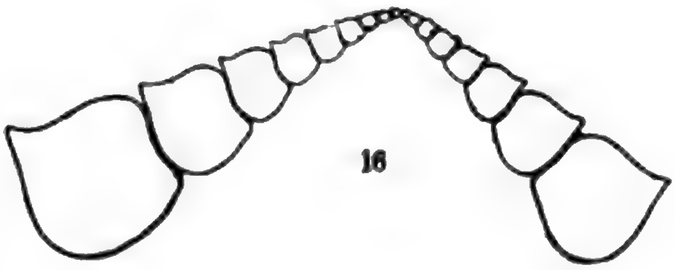
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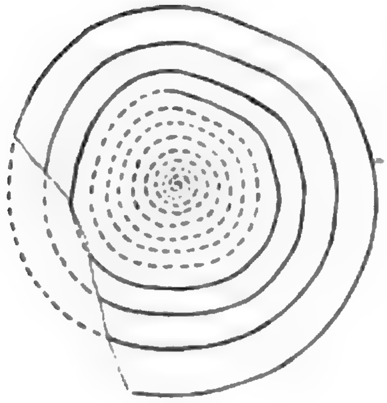
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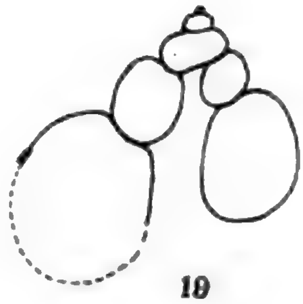
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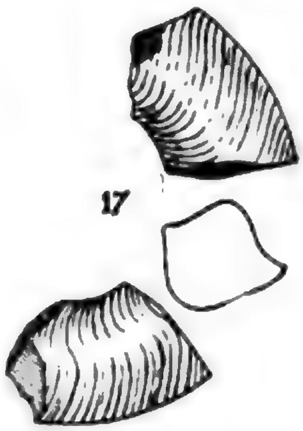
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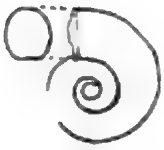
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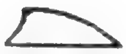
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PLATE VI

1. *Euomphalus winonensis* n. sp. Upper surface of a fragment reconstructed from other specimens.

2 and 3. *Cyrtoceras winonicum* n. sp. Fragments of two shells preserved as interior casts. The last has a part of the chamber of habitation attached.

4. *Cyrtoceras dresbachense* n. sp.

5, 6 and 7. *Piloceras corniculum* n. sp. (5) Specimen, drawn with the concavity of the last septum indicattd in dotted lines. (6) Another specimen and (7) cross section of the same.

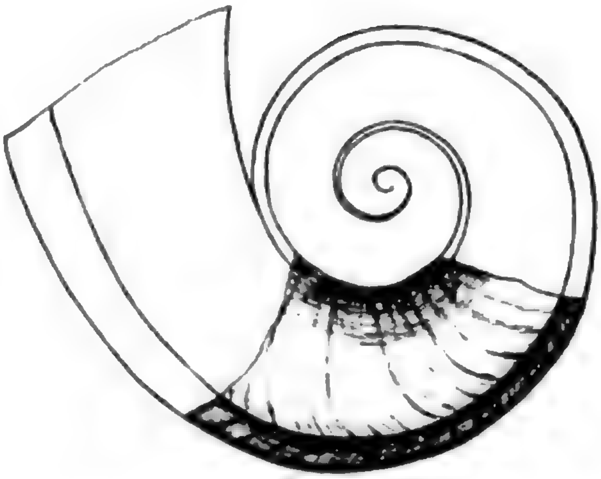
8, 9 and 10. *Ascoceras gibberosum* n. sp. Side view of the septate portion as an internal cast, and (9) longitudinal and (10) transverse sections of the same.

11. *Endoceras consuetum* n. sp.

12. *Lingula dolata* n. sp.

13. *Receptaculites*-like structure from the Shakopee.

14. *Subulites exactus* n. sp.



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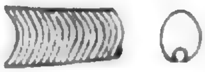

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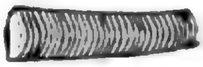

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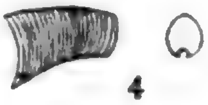

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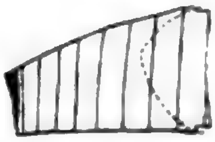

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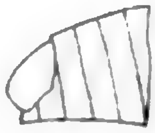

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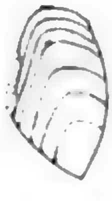

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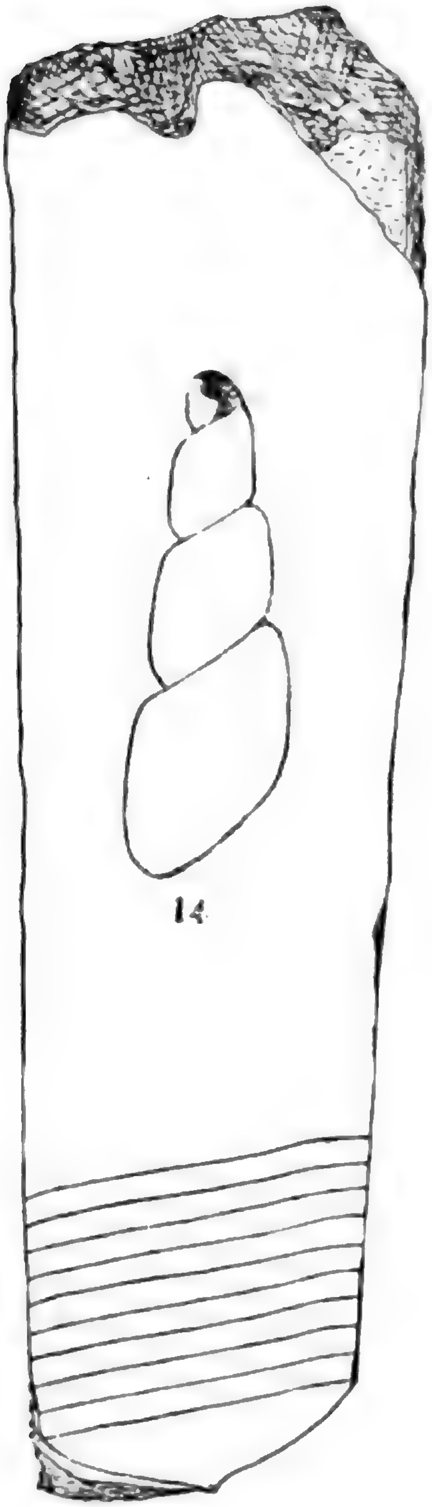

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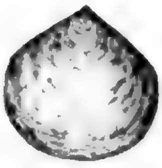

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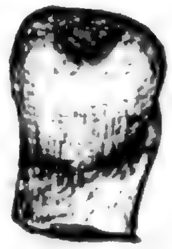

13

CONTENTS

PAGE

Proceedings of the Academy, January, 1892 to November, 1894......... 1

Osborn, H. L.—*Paper A.*—The Rodentia in evolution; a preliminary study.. 46

Sardeson, F. W.—*Paper D.*—The Saint Peter sandstone..................... 64

Sardeson, F. W.—*Paper F.*—The Fauna of the Magnesian Series........ 92

Sheldon, E. P.—*Paper B*—Notes on the Minnesota species of Laciniaria.. 56

Sheldon, E. P.—*Paper C.*—Notes on the Alpine characteristics of the Minnesota crest flora of the *Coteau des Prairies*..................... 60

Sheldon, E. P.—*Paper E.*—The Rum River valley as a botanical district.. 88

BULLETIN

OF THE

MINNESOTA ACADEMY OF NATURAL SCIENCES

VOL. IV, NO. 1 PART 2

PROCEEDINGS AND ACCOMPANYING PAPERS 1892-94

C. W. HALL, EDITOR

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AUG 11 1905

[*Paper G*]

THE STRUCTURE, LITHOLOGY AND GENESIS OF THE MAGNESIAN SERIES OF THE NORTHWESTERN STATES

[ABSTRACT]

By C. W. HALL

An investigation of the dolomites of the upper Mississippi river valley was begun more than a year ago.* The studies to follow have been only in part carried out. This paper, presented at the meeting of the Academy held December 6th, 1892, contained historical matter, a discussion of the method of the study pursued, and a presentation of some microscopic results. In view of the writers' intention to take up again the lines of experimentation and examination begun, and the lack of space in this Bulletin, at the present time only a summary is given of the points discussed and the results then set forth.

But that some of the results of the field work and necessary comparisons may be available, it is thought best to present a key to the nomenclature of the Magnesian series. This is given on the basis of the naming applied in the paper of the authors just cited. The names were derived by an historical process and are apparently in undisputed use at the present time. In order that the formations may be recognized in the field under the names assigned to them and that the literature may be used without confusion, this key has been prepared. Dr. F. W. Sardeson has assisted in its tabulation.

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*The general results of the investigation have been published alsewhere owing to the unavoidable delay in the publication of this Bulletin. For these results the reader is referred to "The Magnesian Series of the Northwestern States," by C. W. Hall and F. W. Sardeson, Bulletin Geol. Soc. America, Vol. VI, 1895, pp. 167-198, with one plate.

Of the names which occur in the Minnesota Geological and Natural History Survey Reports, the meaning is as follows:

ST. LAWRENCE means St. Lawrence,
in the Second Annual Report (1873), p. 152.
in the Final Report, vol. 1 (1884), p. 424.
" " " 2 (1888), p. xxi.
" " " " p. 70.
" " " " p. 119.
" " " " p. 160.
" " " " p. 381.

ST. LAWRENCE means Oneota,
in the Fourth Annual Report (1875), p. 32.
in the Fifth " " (1876), p. 29.
in the Final Report, vol. 1 (1884), pp. 217–223.
" " " " p. 254.
" " " " p. 282.

JORDAN means Jordan
in the Second Annual Report (1873), p. 47.
in the Final Report, vol. 1 (1884), p. 426.
" " " 2 (1888), p. 21.
" " " " pp. 70–71.
" " " " p. 121.
" " " " p. 161.
" " " " p. 138.

JORDAN means New Richmond Sandstone,
in the Fourth Annual Report (1875), p. 35.
in the Fifth Annual Report (1876), p. 28.
in the Final Report, vol. 1 (1884), pp. 217–221.
" " " " p. 252.
" " " " p. 284.
" " " " p. 335.

MAGNESIAN LIMESTONE means Oneota,
in the Final Report, vol. 2 (1888), p. 21

LOWER MAGNESIAN means Oneota,
in the Final Report, vol. 2 (1888), pp. 9, 12, 36.
" " " " pp. 70–72.
" " " " p. 409.

LOWER MAGNESIAN means Oneota, New Richmond and Shakopee together,
in the First Annual Report, (1872), pp. 78, 80.
in the Fourth " " (1875), p. 32.
" " " " p. 87.
in the Final Report, vol. 1 (1884) p. 253.
" " " 2 (1888) p. 124.
" " " " p. 162.

Main Body of Limestone means Oneota and Shakopee,
in the Final Report, vol. 2. (1888), p. 382.

New Richmond or **Richmond** means New Richmond,
in the Final Report, vol. 2 (1888), p. 9, 11, 37.
" " " " p. 80–83
" " " " p. 388.

Shakopee means Shakopee formation,
in the Fourth Annual Report (1875), p. 38.
in the Fifth Annual Report (1876), p. 26.
in the Final Report, vol. 1 (1884), pp. 217–219.
" " " " p. 252.
" " " " p. 285.
" " " 2 (1888) p. 21.
" " " " pp. 9, 10, 38.
" " " " pp. 70–73.

Shakopee means Oneota, New Richmond and Shakopee together,
in the Second Annual Report (1873), p. 138.
in the Sixth Annual Report (1877), p. 120.
in the Final Report, vol. 1 (1884), p. 336.
" " " " p. 429.
" " " 2 (1888), p. 124.

In the Wisconsin Geological Survey reports, especially the Final Reports of the Survey of 1873-1879, the name Potsdam sandstone is uniformly used for all the formations from and including the Jordan sandstone downwards into the Cambrian. The name Madison beds or sandstone is consistently used for an upper part of the Potsdam, and also the name Mendota beds or limestone for the next lower part. As now known, these two formations are equivalent to the formations in Minnesota, respectively Jordan (syn. Madison) sandstone and St. Lawrence (syn. Mendota) formation. Unfortunately the rules of nomenclature here require the newer names to yield. The change can be easily applied because the displaced names were consistently used in relation to the geologic formations. Detailed citation is therefore not necessary.

The name Lower Magnesian limestone is applied in the Wisconsin reports without discrimination between the upper, Shakopee, and lower, Oneota, dolomite, both of which formations the name covers, excepting by one author, L. C. Wooster (vol. 4, 1882, p. 106), who distinguishes the Lower Magnesian proper (i.e., Oneota) from the Willow River beds (i.e., Shakopee) and designates the sandstone between them New Richmond.

In Iowa the small extent of surface exposures is productive of fewer descriptions. The name Potsdam sandstone included all formations below the Lower Magnesian limestone, and the name Lower Magnesian covered all rocks to the St. Peter sandstone until recently. McGee uses the name Oneota for the formation exclusive of the Shakopee and New Richmond.* Charles R. Keyes follows McGee in his studies of the current year.†

The further topics of the paper are summarized as follows:

1. In Minnesota there are two well defined dolomite formations, Oneota and Shakopee. Below these is a great thickness of sandstone and green shales into which a few stray bands of dolomite enter and give dolomitic character to certain layers of the St. Lawrence. Above the Shakopee, after more than one hundred feet of sandstone, comes the Galena series characterized by a weakening of the dolomitic habit through the occurrence of a limestone with less than fifteen per cent. of magnesium carbonate.

2. A marked faunal break separates the St. Lawrence formation from the sandstone beneath; another break occurs between the Oneota and Shakopee, the two dolomites named above, and a third betweeen the Shakopee and St. Peter sandstone. These three faunal breaks establish at least three faunas and three corresponding time divisions between the Algonkian and the St. Peter (Chazy).

3. Below the St. Lawrence, and extending downwards to Algonkian rocks, lies a sandstone, generally a very pure quartz sand but locally of a varying composition, which is recognized by paleontologists as upper Cambrian. Above the upper Cambrian lies the Lower Calciferous, carrying the St. Lawrence sandstone, shale and dolomite; the Jordan sandstone and the Oneota dolomite: then follows the upper Calciferous consisting lithologically of the New Richmond sandstone and Shakopee dolomite.

4. The clean, purely quartzose condition of the sandstone formations associated with the dolomites, together with the semi-

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*The Pleistocene History of Northeastern Iowa, by W J McGee, Eleventh Ann. Rep. Director U. S. Geol. Survey, 1890, part. I, p. 332.

†The Geological Formations of Iowa, by Charles Rollin Keyes. Iowa Geological Survey, Vol. I, First Ann. Rep. for 1892. Des Moines, 1893, p. 23.

crystalline character of the shales associated with them, leads to the conclusion that the dolomites and all associated rocks must have undergone extensive chemical changes.

5. The dolomites assume many interesting characters. The development of rhombohedral grains is a very general process; the structure of the rhombohedra presents many crystallographic features; locally too, the formation of a siliceous oolite is equally characteristic of the Shakopee.

December 6, 1892.

[*Paper H*]

METEOROLOGICAL STATISTICS

By William Cheney

These statistics are the result of personal Meteorological Observations, made at Minneapolis, Minnesota, by William Cheney, voluntary observer United States Weather Bureau since 1864. The tables here given cover the period from 1883 to 1894 inclusive and are followed by a Summary of mean weather conditions and dates of maximum and minimum temperatures.

TEMPERATURES

Year	Spring	Summer	Autumn	Winter	Mean	Maxim'm Temperature	Minim'm Temperature	Precipitation
1883	39.10	66.86	42.30	6.11	38.90	July 1-2 Aug. 21 } .....94°	January 22...—31°	26.977
1884	41.26	67.32	45.67	9.26	40.33	Aug. 15, Oct. 2 90°	January 4....—33°	29.683
1885	40.87	67.23	44.70	5.13	40.47	July 8..........94°	January 2....—38°	26.665
1886	45.46	69.99	45.32	12.85	42.26	August 15 .....95°	Jan. 10, 22 Feb. 2 } ..—29°	29.579
1887	44.65	70.15	42.50	5.35	41.42	July 14-15......96°	January 7....—34°	32.791
1888	35.94	68.32	44.69	8.58	40.02	June 15, July 11 92°	January 21...—42°	30.125
1889	46.38	68.77	43.41	17.40	44.32	July 7 ....99°	February 23..—26°	18.360
1890	40.90	68.08	44.87	18.23	42.66	July 30 ....95°	January 16...—21°	27.072
1891	43.31	66.27	46.11	18.24	43.81	August 8 ......98°	February 4 ..—21°	26.696
1892	40.02	67.96	45.91	19.19	42.21	June 11-12 .....93°	January 19... —29°	37.895
1893	38.53	71.23	46.29	9.21	41.11	July 24........101°	February 1, 4 —28°	32.227
1894	47.40	73.80	46.23	11.90	47.63	July 11, 26 ....105°	January 24...—28°	21.680
Average	41.99	68.84	44.92	11.78	41.68			28.312

1883	Atmospheric Pressure	Temperature of the air (in degrees Fahrenheit)						Precipitation, in inches		0 entirely clear Pr. ct. of cloudiness 10 entire cloudiness	Relative humidity 100 complete saturation	Prevailing winds
			Extremes			Number of times temperature reached—						
MONTHS	Corrected for temperature and elevation	Monthly mean	Maximum	Minimum	Monthly range	90° or above	32° or below	Monthly	Total snowfall			
January	30.089	*-2.64	22	*-31	53	0	31	2.225	22⅛	5.2	.53	N. W.
February	30.165	9.47	41	*-27	68	0	28	0.918	9 3-16	4.5	.62	S. W.
March	29.991	21.97	48	*-12	60	0	31	0.325	1¼	5.0	.66	N. W.
April	29.802	43.62	73	22	51	0	6	3.828	7⅛	5.6	.63	S. E.
May	29.802	51.72	75	33	42	0	0	2.529	0	6.0	.60	S. E.
June	29.770	64.13	88	45	43	0	0	6.590	0	5.1	.70	S. E.
July	29.820	70.25	94	57	37	2	0	4.432	0	5.4	.71	S.
August	29.911	66.19	94	50	44	1	0	0.469	0	5.7	.70	S. E.
September	29.946	55.37	84	29	55	0	2	1.988	0	4.6	.71	S. E.
October	29.981	42.36	74	19	55	0	8	1.166	2⅛	6.5	.73	S. E.
November	29.909	29.16	59	* -2	61	0	28	0.685	⅛	5.2	.66	N. W.
December	30.014	15.16	49	*-21	70	0	30	1.822	10⅜	4.7	.60	N. W.
Total for year			94	*-31	125	3	164	26.977	53 9-16			
Mean for year *-Below zero.	29.933	38.90								5.3	.65	S. E.
1884												
January	30.104	3.83	38	*-33	71	0	31	0.731	7 5-16	4.6	.55	N. W.
February	29.997	8.78	39	*-18	57	0	29	2.225	22⅛	6.7	.62	W.
March	29.993	23.64	58	*-16	74	0	22	0.952	4¼	5.9	.63	W.
April	29.865	43.17	72	21	51	0	8	1.727	3⅛	6.0	.63	N. E.
May	29.813	56.98	82	35	47	0	0	2.991	0	4.8	.60	E.
June	29.873	67.76	87	48	39	0	0	4.181	0	4.0	.75	S. E.
July	29.463	66.99	87	56	31	0	0	1.653	0	5.0	.71	W.
August	29.831	67.21	90	51	39	1	0	3.910	0	5.9	.73	S. E.
September	29.840	61.58	87	47	40	0	0	5.267	0	5.0	.77	S. E.
October	29.919	48.41	90	18	72	1	9	3.079	⅛	5.5	.74	N. W.
November	30.000	27.02	59	*-13	72	0	24	0.660	6⅝	4.6	.70	N. W.
December	30.052	8.58	46	*-32	78	0	31	2.307	24⅝	6.2	.60	N. W.
Total for year			90	*-33	123	2	154	29.683	68 13-16			
Mean for year *—Below zero.	29.896	40.33								5.3	.67	N. W.

1885 MONTHS	Atmospheric Pressure	Temperature of the air (in degrees Fahrenheit)						Precipitation in inches		0 entirely clear Pr. ct. of cloudiness 10 entire cloudiness	Relative humidity 100 complete saturation	Prevailing winds
	Corrected for temperature and elevation	Monthly mean	Extremes		Monthly range	Number of times temperature reached—		Monthly	Total snowfall			
			Maximum	Minimum		90° or above	32° or below					
January	30.073	0.78	42	*-38	80	0	31	0.387	3⅞	4.0	.50	W.
February	29.984	6.02	44	*-30	74	0	28	0.331	3 5-16	4.0	.53	W.
March	29.988	23.66	49	*-7	56	0	31	0.637	6⅞	5.6	.66	W.
April	29.869	43.37	70	19	51	0	8	2.870	2⅜	6.0	.68	S. E.
May	29.459	55.58	86	28	58	0	2	2.075	⅛	6.0	.65	W.
June	29.841	65.29	87	41	46	0	0	3.335	0	5.0	.74	S.
July	29.814	72.59	94	61	33	3	0	4.520	0	7.1	.72	S. E.
August	29.847	63.81	86	45	41	0	0	3.590	0	5.7	.76	N. W.
September	29.850	59.10	84	40	44	0	0	5.270	0	3.6	.73	S. E.
October	29.888	42.47	78	24	54	0	13	1.755	⅛	4.5	.70	N. W.
November	29.886	32.54	52	15	37	0	22	1.005	1 15-16	7.0	.80	W.
December	29.961	20.47	48	*-15	63	0	27	0.890	5 9-16	6.2	.70	S.
Total for year			94	*-38	132	3	162	26.665	24 13-16			
Mean for year *—Below zero.	29.872	40.47								5.4	.68	W.
1886												
January	30.082	3.76	31	*-29	60	0	31	3.012	30⅛	6.8	.59	N. W.
February	29.982	14.31	46	*-29	75	0	29	0.550	5½	5.2	.65	N. W.
March	29.923	27.46	60	*-9	69	0	29	1.510	13	6.5	.69	W.
April	29.871	49.17	81	14	67	0	5	3.617	0	6.5	.70	S. E.
May	29.812	59.70	83	42	41	0	0	0.990	0	4.5	.58	S.
June	29.820	66.50	91	48	43	2	0	5.350	0	4.4	.67	N. W.
July	29.817	73.12	93	58	35	4	0	2.465	0	4.5	.67	N. W.
August	29.796	70.35	95	45	50	8	0	2.330	0	5.0	.67	S. E.
September	29.824	57.70	87	32	55	0	1	5.440	0	6.6	.75	S. E.
October	29.952	52.02	81	24	57	0	6	0.460	0	4.6	.68	S.
November	29.891	26.23	68	*-3	71	0	25	2.485	23½	5.0	.67	W.
December	30.096	6.76	42	*-24	66	0	29	1.370	9	5.0	.56	N. W.
Total for year			95	*-29	124	14	155	29.579	81⅛			
Mean for year *—Below zero.	29.906	42.26								5.4	.66	N. W.

1887 MONTHS	Atmospheric Pressure*	Temperature of the air (in degrees Fahrenheit)						Precipitation in inches		0 entirely clear Pr. ct. of cloudiness 10 entire cloudiness	Relative humidity 100 complete saturation	Prevailing winds
	Corrected for temperature and elevation	Monthly mean	Extremes		Monthly range	Number of times temperature reached—		Monthly	Total snowfall			
			Maximum	Minimum		90° or above	32° or below					
January	29.935	0.23	28	*-34	62	0	31	1.368	13 11-16	5.1	.52	N. W.
February	30.079	9.05	42	*-28	70	0	28	2.225	22¼	5.0	.58	S. E.
March	30.024	25.82	47	*-12	59	0	29	0.707	4⅞	5.0	.69	N. W.
April	29.780	44.40	80	15	65	0	9	3.758	4⅜	5.5	.64	S. E.
May	29.793	63.73	88	40	48	0	0	2.590	0	3.1	.58	S. E.
June	29.800	69.67	93	51	42	2	0	3.170	0	4.6	.70	S.
July	29.891	74.75	96	61	35	8	0	3.490	0	4.4	.67	S.
August	29.856	66.02	92	45	47	1	0	4.170	0	6.8	.74	S. E.
September	29.937	57.15	83	37	46	0	0	4.170	0	4.7	.76	S. E.
October	29.908	40.88	67	12	55	0	13	2.450	2	5.2	.70	N. W.
November	29.958	29.47	63	*-20	85	0	21	0.890	7⅜	5.4	.67	N. W.
December	29.954	15.88	39	*-22	61	0	31	3.803	33⅛	8.0	.72	N. W.
Total for year			96	*-34	130	11	162	32.791	86 3-16			
Mean for year * Below zero.	29.910	41.42								5.2	.66	N.W.&S.E.

1 8 8 8

MONTHS	Corrected for temperature and elevation	Monthly mean	Maximum	Minimum	Monthly range	90° or above	32° or below	Monthly	Total snowfall	0 entirely clear Pr. ct. of cloudiness 10 entire cloudiness	Relative humidity 100 complete saturation	Prevailing winds
January	30.184	*-1.68	34	*-42	76	0	31	1.262	12⅝	5.2	.48	N. W.
February	29.972	11.54	40	*-35	75	0	29	1.108	8⅜	6.0	.62	N. W.
March	30.040	17.77	42	*-13	55	0	31	2.462	21⅛	6.0	.69	N. W.
April	30.014	40.22	74	25	49	0	15	5.125	3	5.2	.70	N. W.
May	29.794	49.82	77	30	47	0	2	6.210	1½	7.0	.71	N. W.
June	29.721	67.43	92	49	43	2	0	2.500	0	6.3	.71	S. E.
July	29.855	72.00	92	60	32	1	0	5.560	0	6.0	.75	S. E.
August	29.863	65.52	91	46	45	1	0	2.270	0	4.7	.79	S.
September	29.925	56.98	79	35	44	0	0	1.580	0	4.2	.74	N. W.
October	29.825	44.12	73	30	43	0	5	0.990	0	6.6	.74	N. W.
November	30.028	32.97	65	4	61	0	23	0.450	1½	5.4	.75	N. W.
December	29.950	23.61	56	4	52	0	29	0.608	2⅜	6.3	.71	N. W.
Total for year			92	*-42	134	4	165	30.125	50½			
Mean for year *—Below zero.	29.931	40.02								5.8	.70	N. W.

1889 MONTHS	Atmospheric Pressure	Temperature of the air (in degrees Fahrenheit.)						Precipitation in inches		o entirely clear Pr. ct. of cloudiness 10 entire cloudiness	Relative humidity 100 being complete saturation	Prevailing winds
	Corrected for temperature and elevation	Monthly mean	Extremes		Monthly range	Number of times temperature reached—		Monthly	Total snowfall			
			Maximum	Minimum		90° or above	32° or below					
January	29.929	18.13	40	*-12	52	0	31	1.035	7⅛	5.1	.70	N. W.
February	30.068	10.45	47	*-26	73	0	28	1.363	13⅛	5.0	.62	N. W.
March	29.939	34.87	63	17	46	0	25	1.070	4½	5.0	.66	N. W.
April	29.883	48.35	74	28	46	0	3	1.530	0	5.3	.56	N. W.
May	29.811	55.93	81	38	43	0	0	3.060	0	5.5	.58	N. W.
June	29.818	65.11	90	45	45	1	0	1.530	0	6.3	.67	S.
July	29.790	70.97	99	56	43	4	0	3.160	0	4.8	.70	S. E.
August	29.862	70.24	93	55	38	5	0	2.390	0	3.5	.67	S.
September	29.823	58.19	91	37	54	1	0	0.820	0	5.0	.69	S. E.
October	30.039	43.78	75	25	50	0	13	0.060	0	3.6	.68	S. E.
November	30.010	28.25	54	*-5	59	0	28	1.082	8⅝	4.8	.72	N.W.
December	29.904	27.53	44	*-8	52	0	29	1.260	9⅜	6.6	.73	S. E.
Total for year			99	*-26	125	11	157	18.360	43⅛			
Mean for year * Below zero.	29.906	44.32								5.0	.66	N.W.
1890												
January	30.075	9.67	42	*-21	63	0	31	1.037	10⅜	6.0	.59	N. W.
February	29.980	17.48	47	*-12	59	0	27	1.275	11¼	5.5	.65	N. W.
March	30.013	22.15	50	*-15	65	0	29	1.685	11¾	5.4	.68	N. W.
April	29.939	47.49	77	21	56	0	3	1.750	0	4.0	.60	S.
May	29.752	53.05	84	31	53	0	2	4.160	2½	6.0	.63	N. W.
June	29.769	69.16	94	54	40	3	0	5.970	0	6.0	.79	S. E.
July	29.827	71.01	95	58	37	5	0	1.900	0	4.8	.74	N. W.
August	29.887	64.07	94	50	44	2	0	2.590	0	5.3	.75	S.
September	29.936	56.04	85	35	50	0	0	3.350	0	4.3	.78	S. E.
October	28.983	44.58	70	20	50	0	8	2.460	0	7.0	.77	N. W.
November	29.099	33.98	55	8	47	0	24	0.390	3½	4.5	.74	N. W.
December	29.086	23.26	51	*-1	52	0	29	0.505	2¼	5.0	.71	N. W.
Total for year			95	*-21	116	10	153	27.072	42⅛			
Mean for year *—Below zero.	29.696	42.66								5.3	.70	N. W.

1891 MONTHS	Atmospheric Pressure	Temperature of the air (in degrees Fahrenheit.)						Precipitation in inches				
	Corrected for temperature and elevation	Monthly mean	Extremes		Monthly range	Number of times temperature reached—		Monthly	Total snowfall	o entirely clear Pr. ct. of cloudiness 10 entire cloudiness	Relative humidity 100 being complete saturation	Prevailing winds
			Maxi-mum	Mini-mum		90° or above	32° or below					
January	29.072	20.67	43	0	43	0	30	0.863	8⅝	5.5	.68	N. W.
February	28.993	10.78	44	*-21	65	0	28	2.108	20⅜	4.6	.60	N. W.
March	29.007	23.25	47	*- 6	53	0	27	1.620	12	7.0	.70	E.
April	29.024	47.85	83	17	66	0	7	2.025	4	4.4	.69	N. W.
May	29.162	58.84	84	36	48	0	0	1.540	0	3.6	.56	S.
June	28.982	65.22	88	42	46	0	0	4.010	0	6.5	.77	S. E.
July	29.105	66.13	85	51	34	0	0	2.800	0	5.3	.75	N. W.
August	29.064	67.47	98	46	52	4	0	3.680	0	5.4	.70	N. W.
September	29.085	65.84	91	43	48	7	0	1.925	0	4.4	.68	S.
October	29.099	46.90	72	26	46	0	6	1.840	0	6.3	.73	N. W.
November	29.053	25.59	56	*-13	69	0	25	0.825	8⅛	6.6	.72	N.W.
December	28.902	27.19	49	*-6	55	0	27	3.460	6⅓	6.0	.73	S. E.
Total for year			98	*-21	119	11	150	26.696	56⅛			
Mean for year * Below zero.	29.051	43.81								5.5	.69	N.W.

1892

MONTHS	Corrected for temperature and elevation	Monthly mean	Maxi-mum	Mini-mum	Monthly range	90° or above	32° or below	Monthly	Total snowfall	o entirely clear Pr. ct. of cloudiness 10 entire cloudiness	Relative humidity 100 being complete saturation	Prevailing winds
January	29.106	9.52	43	*-29	72	0	30	0.660	2½	3.7	.59	N. W.
February	29.134	20.86	41	*-20	61	0	27	1.535	13½	6.5	.70	N.
March	29.112	27.09	55	*- 4	59	0	25	1.152	8⅜	5.4	.71	N. W.
April	29.060	42.02	64	18	46	0	14	0.680	0	6.4	.64	S. E.
May	28.979	50.94	74	30	44	0	4	7.510	2	8.1	.73	N.
June	29.885	64.51	93	40	53	2	0	6.250	0	6.6	.78	S. E.
July	29.985	70.88	90	49	41	1	0	12.010	0	5.6	.78	S. E.
August	29.972	68.50	87	42	45	0	0	4.700	0	5.1	.78	S. E.
September	29.999	61.09	84	39	45	0	0	1.540	0	3.7	.79	N. W.
October	30.018	49.31	83	20	63	0	7	0.420	0	4.1	.70	S. E.
November	30.043	27.32	52	0	52	0	27	0.601	5 5-16	7.4	.74	S. E.
December	30.116	14.53	38	*-18	56	0	34	0.837	6⅜	6.1	.66	N. W.
Total for year			93	*-29	122	3	165	37.895	39 1-16			
Mean for year *—Below zero.	29.617	42.21								5.7	.71	S. E.

1893 MONTHS	Atmospheric Pressure	Temperature of the air (in degrees Fahrenheit.)					Precipitation in inches				
	Corrected for temperature and elevation	Monthly mean	Extremes		Monthly range	Number of times temperature reached—		Monthly	Total snowfall	0 entirely clear Pr. ct. of cloudiness 10 entire cloudiness	Relative humidity 100 being complete saturation	Prevailing winds
			Maxi-mum	Mini-mum		90° or above	32° or below					
January	30.067	3.70	33	*-26	59	0	31	1.825	18⅛	5.3	.60	N. W.
February	30.125	9.40	38	*-28	66	0	28	1.800	18	7.5	.65	N. W.
March	30.038	22.50	49	*-12	61	0	28	1.647	9⅞	7.0	.71	N. W.
April	29.870	39.10	70	19	51	0	23	6.220	19.6	8.3	.77	N. W.
May	29.881	54.00	82	32	50	0	2	2.515	0.5	7.0	.68	S. E.
June	29.835	71.70	93	45	48	7	0	1.760	0	6.0	.73	S.
July	29.867	73.70	101	53	48	9	0	1.930	0	5.0	.71	N. W.
August	29.923	68.30	100	42	58	5	0	6.800	0	5.8	.74	N. W.
September	29.906	60.50	90	28	62	1	3	2.760	0	5.0	.75	S. E.
October	29.915	48.30	79	14	65	0	7	1.420	0	5.0	.77	N. W.
November	29.998	30.08	69	*-13	82	0	24	1.080	10.8	6.0	.71	N. W.
December	30.102	12.00	41	*-20	61	0	31	2.470	15.9	7.0	.61	N. W.
Total for year			101	*-28	129	22	177	32.227	92.9			
Mean for year *-Below zero.	29.961	41.11								6.2	.70	N. W.
1894												
January	30.096	10.20	41	*-28	69	0	30	1.37	13.7	5.2		N. W.
February	30.122	13.5	41	*-16	57	0	28	.08	.80			S.
March	29.934	34.5	75	*- 3	78	0	22	3.05	11.1			N. W.
April	29.920	49.2	79	24	55	0	5	4.53	2.7			S. E.
May	24.903	58.5	88	36	52	0	0	3.17	0			N.
June	29.852	72.6	96	38	58	7	0	1.00	0			S.
July	29.909	76.5	105	50	55	19	0	.27	0			N. W.
August	29.954	72.3	97	45	52	10	0	.55	0			N.
September	29.909	63.2	96	34	62	2	0	1.20	0			N. W.
October	29.842	48.4	74	29	45	0	2	4.52	.7			N. W.
November	30.078	27.1	52	*- 6	58	0	28	.52	2.20			N. W. & S
December	30.065	25.6	47	*-15	62	0	28	1.36	2.30			S.
Total for year			105	*-28	133	38	143	21.68	32.8			
Mean for year *—Below zero.	29.548	47.63										N. W.

[*Paper I*]

LETTERS FROM THE MENAGE SCIENTIFIC EXPEDITION TO THE PHILIPPINE ISLANDS

By Dean C. Worcester and Frank S. Bourns

[The following letters were written by the two young men who went out as leaders of the Menage Scientific Expedition to the Philippine Islands. This Expedition was fitted out and maintained from the summer of 1890 until the close of 1892, by Louis F. Menage, Esq., a citizen of Minneapolis and a member of the Minnesota Academy of Natural Sciences. While these letters were written as reports to the Academy of the progress of the work of the Expedition, they form so interesting an itinerary of exploring scientists and so instructive an account of a collector's adventures in a strange region, that they are published for wider reading. Mr. L. A. Griffin has selected for publication here only the paragraphs pertaining to the scientific aspects of the work of the Expedition.

After leaving the Philippines, Mr. Bourns spent some time in Borneo for the double purpose of taking notes on the relations of the Borneo fauna and that of the islands which had been so successfully explored and of securing some orangs for the Academy. His account of "An Orang Hunt in Borneo," written for another use by the Academy, is so interesting and so fitting an associate to the letters that it is given a place at their close.—C. W. Hall.]

I.

Salay Davo, Guimaras (opposite Iloilo),
Philippine Islands, December 12, 1890.

Gentlemen of the Minnesota Academy of Natural Sciences,
Minneapolis, Minnesota:

Since our arrival in the Philippine Islands, Sept. 6th, we have been anxiously awaiting the letter promised us from the Bishop of Minnesota to the Archbishop of Manila and instructions as to which of the methods of preparing birdskins we should follow. But as mail up to October 28th has arrived and no communication from you has reached us, and as it is past the end of the first quarter, we have decided not to delay longer in writing you, and accordingly have the honor to submit the following report.

We were subjected to a great deal of annoying delay in Manila, on account of the non-arrival of our letter from Spain. Since our visit here in 1887 the laws regarding firearms have been greatly changed, making it much more difficult to import them and nearly impossible for a foreigner to obtain permission to use them. Just as we had obtained permission to pass our goods at the Custom House and to procure proper licenses, a Royal Order from Spain was received by the Governor General. This fortunate arrival aided us greatly. Not only were our requests promptly granted, but in addition we were given a special letter from the Governor General to the Governors of all the provinces which we intended to visit. This is not only a letter of introduction but is also an order to the effect that all our reasonable requests be granted and our safety be looked after by the Governor of the province to whom the letter might be presented.

Besides this letter we obtained one from the Rt. Rev. Netter, acting Archbishop of Manila, addressed to the resident priests of the Philippines. This letter will be, and has already been, of great service to us, as in many of the smaller and more out of the way places the priest is the only white man to be found and is therefore a man of much influence.

Being thus well supplied with letters and papers from both civil and ecclesiastical authorities, we were prepared to start out on our work. We decided for our first trip to visit Panay, Guimaras, Negros and Siquijor, but as the boat did not leave for three weeks, we were compelled to look out for some suitable place near Manila where we could put in the intervening time. It was difficult to find such a place as all the region around Manila is under cultivation and for our work we must be near the forest. Finally we met an American named Thomas Collins, who told us that he thought his place would just suit us. He was engaged in the wood business at a small place called Quisao, about forty miles from Manila on the eastern side of the great Lake of Bay. His wood boats were going and coming every week, making it easy of access, so we accepted an invitation to visit him.

Taking small river boats (bancas) at Manila, we went up the Pasig river to the lake, where we found one of Mr. Collins' cascas or wood boats awaiting us. It was evening when we reached the boat and three o'clock A. M. before we set sail, but the wind being favorable, by noon of the next day we were at Quisao, and soon comfortably established in Mr. Collins' house and ready for work. The forest was farther off than we had expected to find it, and could only be reached by two hours' hard tramping, but we decided to make the best of it.

Unfortunately it was still the rainy season and we were in consequence much hindered by the weather.

We stayed there from September 27th to October 15th, working as much as the weather and our strength would permit, and then started back to Manila. We started Wednesday in order to have plenty of time to catch the regular monthly boat leaving Saturday for Capiz, the town in North Panay we wished to visit next. We expected to reach Manila in twenty-four hours, thus leaving us ample time to make all necessary preparations for our projected five months' trip in the Central Islands.

But we soon found that Philippine weather and Philippine boats, especially of the casco variety, are not to be depended on. A heavy storm drove us upon a rocky shore. The experiences of the next three days were not pleasant, but we escaped being wrecked, and reached Manila on Sunday morning, missing, as we supposed, the boat for Capiz. On our arrival however we were pleased to find that the same storm which had delayed us had also delayed the steamer, but that she would sail at three o'clock that afternoon. We had five short hours in which to make our preparations, but succeeded in getting the boat just as she was starting out.

The results of our work in Luzon show very significantly that much remains to be done in these Islands. Luzon is better known from a geological point of view than any other island in the group. One hundred and seventy-seven species of birds were already recorded, yet during our short stay in a locality close to Manila, which has been frequently visited by ornithologists, we obtained eight species of birds not previously recorded from that island.

The total number of species obtained by us was sixty-one; the number of specimens, one hundred and seventy-one. We also obtained a fine lot of alcoholic material. We shot the largest iguana of which we have any knowledge. It has been stated that these creatures never exceeed five feet in length, but the specimen mentioned measures five feet and four inches. On dissection two full grown chickens were found in its stomach. A venomous snake nine feet and four inches in length, which we shot, we have preserved in alcohol.

We were disappointed in not finding land shells abundant, but hope to be able to obtain a good set on our trip to north Luzon.

Our steamer reached the mouth of the Capiz river at eleven o'clock Monday night. We were landed on the shore with all our baggage about twelve. By two however we had everything safely under cover in a nipa house, and soon after had our hammocks strung. Next morning we sent our baggage by boat up to Capiz, while we went overland, a distance of about three miles. We went directly to the tribunal or town house and finding a large room suitable to our purposes, moved in. After making our calls on the various officials, we began to look around for forest. The surrounding country was low and swampy, and planted almost exclusively with the nipa palm. The long leaves of this palm furnish an excellent thatching material, very generally used, while the blossom stalk furnishes a favorite beverage called palm wine or tuba de nipa. This wine is very similar to the tuba de coco, or wine obtained from the cocoanut palm. The tuba de nipa however, besides being used as a beverage, is very largely used in the manufacture of a stronger distilled wine or even of alcohol, and many stills for its preparation may be found around Capiz.

We had been previously assured that we should find good forest around Capiz, but in this we were disappointed. Wednesday, acting upon the advice of the priest of the town, one of us went on horseback to Panay, a small village eight or ten miles away, expecting to find good forest there. In this we were again disappointed, the region around Panay being very similar to that around Capiz. No time was lost however as the small boys of Capiz proved to be very enterprising, and in return for a few coppers supplied us with wild cats, birds, iguanas, monitors, snakes, lizards, etc. For over a week we worked from early morning till late at night, and only got our work finished when we refused to buy any more specimens. Living Viverra tangalunga and Paradoxurus philippinensis were brought in and as we had an abundant supply of fresh meat we kept them alive for some time, and made interesting observations on their habits. We were glad to obtain iguanas in the way we did. They are so tenacious of life as to be able to run for a considerable length of time after having the heart cut out, and it is therefore exceedingly difficult to obtain them with a shotgun without injuring them greatly as specimens. We obtained perfect skeletons of two of the largest size, and skins of half a dozen others. As it takes half a day's work either to skin or to skeletonize one of these animals, we hope that those prepared may prove acceptable to the Academy.

At the end of a week, another trip on horseback was made in search of forest, but like the previous one was unsuccessful. It was evident that forest was not to be found within ten miles of Capiz. On Friday, October 31st, acting on the recommendation of the Governor of the province, we started for Balete, a small place some thirty-five or forty miles away. The Governor assured us that virgin forest surrounded the town.

The first day's journey was by sea, the night being spent in a small town called Batan. In the morning we transferred our baggage to a small river boat or faroto and continued our journey. We followed the Jalo river up to Balete, where we were well received by village authorities, and gladly accepted the invitation of the native priest to stop with him.

A short investigation satisfied us that there was no more forest around Balete than around Capiz. We had however, on our way up the river, passed several large colonies of fruit bats, and upon these we now prepared to descend. Within a week we put up forty-four skins and four skeletons, besides some thirty birds and considerable alcoholic material. Unfortunately five of the skins and the four skeletons were destroyed in a rather peculiar manner. It is quite a common custom in the Philippines to keep pigs in the parlor, but we did not suppose that our host the priest followed the custom. We were mistaken however, for on our return from a two days' hunt down the river we found that five of the skins and the four skeletons which we had left nailed to the wall a little too near the floor had been destroyed by the priest's pet pig.

On Monday, November 10th, with a light outfit, we embarked in two small river boats, and started up the river, determined to reach the forest if possible. The river soon became so small that it was very difficult to get along, even with our small boats. The boatmen were often compelled to draw the boats by hand over long rifts or small waterfalls. After eight hours of this kind of traveling we reached the house where we were to stop. It was the last house of any size on the river and is the property of a native of some means, who is engaged in growing hemp on the mountain sides. We were still distant about a three hours' walk from the forest, but were as near as we could get with our baggage.

Our first day's hunt convinced us that we had struck good ground, so we settled down for ten days' work. The forest was too far away to make it practicable to go there, shoot our birds, return, and skin them the same day, so we adopted the following plan of work:

One of us accompanied by a guide would start early in the morning for the woods. At noon a messenger from the house would take him his dinner and a supply of loaded shells, and carry back the birds shot that morning. At night he would again be sent with food for supper and breakfast, and would take back the birds shot in the afternoon. A small hut on the edge of the jungle furnished a shelter for the night. The next day the same operations were repeated, the hunter returning at night. But few paths could be found, most of them leading along the river or its branches. In consequence the hunter's clothes were wet all day, and this, combined with the hard tramping over rocks or through the jungle, made two days of this work all that could be endured without rest. So for the next two days the work would be changed, thus making it possible to obtain birds from the distant forest.

But the work was beginning to tell on us. The region was noted for being very unhealthy and the food supply was running low. Two or three days exhausted the supply of chickens, and then we were compelled to depend upon our guns for meat. Bread or beef had not been tasted for three weeks, boiled rice being our staff of life. Four days before we left we purchased our host's parlor pig, and then lived quite well on pork and rice. At the end of ten days we returned to Balete and from there went directly to Capiz, arriving at midnight, November 23rd. On the following Thursday we took the boat for Iloilo, arriving Saturday, November 29th.

During our entire stay in Panay, we were much hindered by rain, but for the next six months we expect to be free from that trouble.

While our collection of birds from Panay is not numerically large, we never put in the same length of time more profitably, so far as scientific results are concerned. We obtained about 250 specimens, representing about 80 species; about 60 of these we were able to identify with considerable certainty.

We were greatly surprised to find Aethopygia magnifica, abundant. This, the most beautiful sunbird of the Philippines, has heretofore been supposed to be confined to the island of Negros. The female we found very difficult to obtain, but we succeeded in getting three specimens. We are under the impression that it is still undescribed, and would be glad to receive definite information on the subject. We also have a fine series of specimens of Cinnyris Guimarasensis, including both male and female. This bird was shot new by us on our previous trip, and was supposed by Dr. Steere to be peculiar to Guimaras. The female however was not obtained, so that we now have it for the first time. In addition to the above we have four species which we believe to be new to science. They are: (1) A small kingfisher of the genus Ceyx. (2) A flycatcher of the genus Zeocephus. (3) A flycatcher, probably of the genus Setaria. (4) A frogmouth of the genus Batrachostomus. The latter is of special interest, being a Bornean genus. One species is already known from Palawan and another from Mindanao, but the finding of one in the central Philippines is a great surprise.

In general, our work on the birds of Panay seems to show a closer relationship between the birds of Panay, Guimaras and Negros than was previously supposed to exist.

Our most valuable find however was among the mammals. We obtained a single specimen of a *true cat* from Panay. The specimen obtained is a young female, but will be sufficient to establish the species. The animal is well known to the natives under the name maray or maral. From the natives we obtained a good description of the adult male. The only record known to us of a cat occurring in the Philippines is in Wallace's "Island Life," where Felis, sp. unknown, is noted as existing in Palawan. We believe that neither Viverra tangalunga nor Paradoxurus philippinensis were previously recorded from Panay.

Maccacus philippinensis was abundant. We send the skin of one large specimen, the skeleton of another, and several skulls. In addition to the fruit bats we send specimens of other species, one of which we hope may prove to be new.

We also send what few shells we could obtain. They were very rare where we were and even a high offer to the natives failed to bring in a satisfactory supply.

Our alcoholic collection comprises specimens of fresh water fish, reptiles, amphibians, crustaceans, preparations of the alimentary canal, etc., etc. We cannot at present give even an approximate estimate of the number of specimens, but the collections from Luzon and Panay fill an eight-gallon cask. We shall ship most of the above at the earliest opportunity, retaining only such specimens of the birds as we need for the purpose of comparison and study.

It may seem strange that we should spend so much time in searching for forest. Many of the islands like Palawan, Mindanao and Mindoro are completely covered with jungle, while others such as Luzon, Panay and Cebu have been under cultivation from before the time of the Spanish settlement, and in them it is difficult or even impossible to find virgin forest. But from this very difficulty, the results, when once the forest is reached, are such as to prove highly satisfactory from a scientific point of view.

On our arrival in Iloilo we apparently were both in good health. But on the very night of our arrival Mr. Worcester was taken down with a fever peculiar to the country, known as "febre pernicioso." This fever was undoubtedly contracted in the mountain region beyond Balete. Fortunately medical assistance was at hand, and serious results were avoided. Although our plans were interrupted to some extent and some time was lost, we are once more in condition to resume work. From here we expect to go to Negros and Siquija, returning to Manila in time to visit Mindoro in the dry season. There we expect to spend three months.

We shall have the honor of reporting to you again at the end of our Negros and Siquija trips.

The last mail brought us the certificate of membership. Allow us to take this opportunity to thank you most heartily for the same.

We remain, gentlemen,

Very truly yours,
Dean C. Worcester,
F. S. Bourns.

II.

Manila, March 19, 1891.

We have the honor to submit the following report of the second quarter's work of the Menage Scientific Expedition.

On December 26th we sailed from Iloilo for the town of Bais, a small place on the eastern coast of Negros, where we arrived on the 28th. We at first thought of settling down in Bais for a couple of weeks and making a collection of sea shells, but found it impossible to get a suitable house. Just at this time aid came to us from an unexpected source. We received a call from a Spanish gentleman who introduced himself as Senor Ignacio Simo. As we afterwards learned, he is the son-in-law of Senor Joaquin Montenegro, the wealthiest sugar planter in this part of Negros.

Senor Simo said that he had heard of the trouble we were having in finding a house and he wished to offer us the use of a small house situated on their plantation. We were very glad to accept this offer and moved out that afternoon. Instead of a small house, we found a large and well furnished one, usually occupied by Senor Montenegro's son, which had been vacated for our especial use. More than this we found that we were in reality the guests of Senor Montenegro and his family. They aided us in every way possible, furnishing us with men, horses, or carts, whenever we required them. Their kindness was greatly appreciated as it not only made it pleasant for us, but facilitated our work greatly.

We worked there for two weeks and then moved into the mountains. Our friends furnished us with twenty-two or twenty-three men, so we were able to take all necessary baggage and food. We went back about a three hours' journey and took up quarters in a native house conveniently situated on the bank of a small mountain stream. We were well located as the forest came up almost to our doors.

The people of the region are all savages, called by the Spaniards Monteses (Mountaineers). They are of course Malays, but have not been converted to Christianity and retain many of their old manners and customs. For instance, one of the old customs which still clings to them is observed when one of their number dies. In the belief that the departed spirit will be lonesome without company, the nearest male relative arms himself, starts out, and kills the first person he meets, black or white. Fortunately the health of the community was good during our stay. Our friends strongly advised us to take along a few soldiers, for the moral effect upon the people, but as we considered that the moral effect would be to make them think we were afraid of them, we deemed it not best to do so. We had, as guides, our host and his son, and experienced no trouble whatever with the savages, though on numerous occasions while hunting in the forest we met parties of them fully armed with their knives and spears. After two weeks of work in this place we returned to the plantation, again being furnished with carriers by our friend Senor Montenegro. The next two or three days were spent in arranging and packing our collections. On January 30th we left Bais for Dumaguete, which place we left two days later for Siquija.

During our stay in the mountains we were able to work to the best possible advantage, the forest being near at hand and our guides familiar with all parts of it.

We obtained 285 birds, of 69 species, 12 of these being new to Negros, and two of the 12 new to us. The first day out we were fortunate enough to obtain a sunbird of the genus Aethopygia (Aethopygia bonita, Bourns and Worc) which has certainly never been described. It is one of the smallest and most brilliantly colored of the Philippine sunbirds. As it feeds in high trees it was very difficult to shoot. Careful and persistent work during our entire stay brought three male and two female specimens. This find was a surprise, as the sunbirds are much sought after by collectors on account of their brilliant plumage, and the chance of discovering new birds belonging to the family is very small.

Our other new bird is a kingfisher of the genus Ceyx, of which we have as yet but a single specimen, a female. Its peculiarities are small size and high color. We also found in Negros the small Ceyx discovered in Panay, though it was by no means as abundant as in that island. We were fortunate also in obtaining four specimens of the cat described in our previous letter. Of the four, two, a male and a female, are adult, one is two-thirds grown and one a kitten.

In one respect we have been particularly unfortunate during our six months' stay. That is in regard to the weather. When we reached Negros we supposed we had left the wet season behind, but during our entire stay in the mountains it rained daily, ending in a sort of cloud burst which raised the stream to such a height that we feared we should not be able to get out in time to catch the steamer for Dumaguete. By actual count the path from our house in the mountains to the plantation crosses the stream thirty-four times, and on the day we went out, though the water had fallen greatly, it was waist deep at most of the crossings. This last grand effort of the elements seems to have exhausted the water supply and we have since had good weather.

From Dumaguete to Siquija we traveled in a small native boat. The journey was pleasant, lasting eight hours, very good time considering the facts that we were heavily loaded and that currents were for the most part against us.

We were soon established in our old quarters in the tribunal, buying birds, shells, etc. We had many friends and acquaintances there, and knowing what we wanted, and that we gave coppers in exchange for birds and shells, they soon were hard at work collecting, and we were as hard at work preserving specimens of all kinds. The people are very poor, a man's daily wages being only five coppers. Many, finding they could make more than that collecting birds and other specimens, spent their whole time at it.

The second day after our arrival Mr. Bourns was taken ill with fever. A liberal use of quinine however stopped it at the end of the third day. Although it showed a tendency to return on one or two occasions, it did not come again in full force until we reached Dumaguete, where it was easily stopped by the use of a very efficient fever remedy which we have, but which we had unfortunately left behind when we went to Siquija.

After a seventeen days' stay in the town of Siquija we moved back into the mountains to a small place called San Antonio, five or six miles from Siquija and about 975 feet above the sea level. We were comfortably established in an old deserted "convento," once occupied by a priest, but since his departure left to go to ruin. The house was large and well arranged for our work, and, although rather too well ventilated, it served our purposes admirably. After two weeks' work in and around San Antonio, we returned to Siquija, and on Friday, March 6th, sailed for Dumaguete.

The results of our work at Siquija are very satisfactory. The number of birds previously known from the island was 54. To this number we have added 27, of which at least four are new to science. They are: (1) Another kingfisher of the genus Ceyx. It is the most brilliant-colored representative of the genus yet discovered. We have three specimens, two males and a female. (2) A kingfisher of the genus Halcyon, very similar to Halcyon Winchelli, but brighter in color, and showing one or two other differences. We have but a single specimen, a male. (3) A very remarkable crested cuckoo, belonging to a genus unfamiliar to us. It is unlike any cuckoo we have ever seen from these islands. We regret we were unable to obtain but a single specimen. (4) A cuckoo which has become protectively modified. It so much resembles a small hawk found in the island that we mistook it for the latter when seen on the wing.

We left San Antonio, arrived at Siquija the same day and on Friday, March 6th, embarked for Dumaguete where we arrived just in time to see a steamer bound for Iloilo (our destination) sail out of the harbor. We fortunately caught a boat on the following Monday. Although we had only 220 miles to go, it took five days to make the journey. The boat stopped at several small towns in Negros and Cebu and in each case several hours.

One of the stops however proved of great value to us. The island of Cebu has been under cultivation for so long that very little forest is now left, and that is being rapidly destroyed. The eastern and southern parts of the island are entirely destitute of anything approaching virgin forest, and but very little is found in the northern and western portions. So difficult is it to find forest, that collectors have done very little there, as is shown by the fact that only fifty-five birds are recorded.

At one of the places where the boat stopped to load sugar, a bit of forest could be seen a mile or two back from the coast. As the boat was to stop several hours, one of the party took a gun and went on shore. The results of a four hours' tramp in the woods show clearly that Cebu is still a good field for a naturalist.

Of ten birds shot, six were new to Cebu and one of these may be a new species.

We shall revisit the place probably about a year from now. Mr. Pickford, an English planter living there, says it is about the only part of Cebu where good forest can be found, and that in a few years none will remain. This gentleman also offered to aid us in any way possible, at any time when we desired to visit the island.

We are now making preparations for our Mindoro trip. It is the most dangerous trip we have yet to make, with the possible exception of the proposed trip to Sulu and the interior of Mindanao, but on the other hand, it is one of the most promising. The island is inhabited by savages, and is very unhealthy. As we have on previous trips succeeded in managing the savages, we think that we can do so this time. We are going into the island in the dry season when the fever is least prevalent, and hope to avoid sickness, but shall not neglect to take along a good supply of medicines. All provisions will have to be taken from Manila, as in the interior it is impossible to get other food than rice or sago, with perhaps an occasional jar of wild honey. Such a bill of fare, as we found by bitter experience, is not calculated to withstand the influence of the climate.

Three months will be spent in the island, during which time we shall probably be beyond mail facilities. On our return to Manila we shall report to you in full regarding the work done in Mindoro.

We remain,

Very truly,

DEAN C. WORCESTER,
F. S. BOURNS.

III.

Sulu, October 5, 1891.

I wrote to Mr. Menage by the last mail, but delayed my letter to you, in order that I might be able to state fully the results of our work here.

This island is undoubtedly the most dangerous place in the Philippines, and this fact has been a great obstacle to us. We have been obliged to hunt together, to keep an armed guard of friendly Moros with us, and to confine ourselves pretty strictly to one region in our hunting. We found on our arrival here that the Moros were not nearly so well provided with firearms as we had been informed, and that they were as a rule very poor marksmen. We also found that their reputed regard for Englishmen was strictly confined to *unarmed* Englishmen, that they were crazy to get hold of firearms, and would kill a man of any nationality for a gun. So we have gone in fighting order. We had little to fear from an open attack, but they could easily hide in the woods and shoot us at short range.

Our instructions from the Governor were brief and significant: "If you meet an armed Moro, order him to put down his arms and retire. If he does not instantly comply, shoot him." Our usual good luck has stood by us however, and we have confined ourselves, in our shooting, to natural history specimens.

The Spanish authorities have been very kind, giving us all possible aid in our work, and in spite of difficulties, the results have been very satisfactory. Before leaving home I compiled a list of Sulu birds, but could find only twenty-seven recorded. Immediately on our arrival I began to make inquiries as to whether other naturalists had been here. I finally heard of a person who was here in 1886. Whether my list includes the results of his work I cannot tell. If it does, we have added fifty-eight species to the birds known from the island. There is no virgin forest however within a day's journey of town, and it is simply out of the question for us to go farther away than that. As it is we have had one or two close shaves. On October 1st ten Moros are reported to have laid an ambush for us on the path we had always taken before. By the merest chance we went another way that day, and they caught a Tartar in the shape of a lot of soldiers, who were out hunting for some cattle that had been stolen the night before. Last Saturday we caught sight of a single Moro sneaking up on us with a rifle. He sprang into the high grass the instant he saw we had discovered him, and made his escape.

* * * * * * *

We have a great puzzle in the small blue kingfishers of the genus Ceyx from this place. They vary from the form with indigo-blue back to the form with silvery-white back and not a vestige of blue about it. One seeing only the two extremes would not hesitate about separating them, but with the series of specimens that we have it is a hard matter to decide what should be done. It is one of the cases where it would be convenient to "throw the intermediate forms out of the window."

Reports as to Tawi Tawi are most encouraging. The natives are friendly, we are assured that we shall find virgin forest at our very doors, and that there are fifty birds there for every one here. The Spanish authorities agree that the island has never been visited, and the natives agree that the birds there are different from those here. Theoretically they ought to be, and we hope to break the record both on number of specimens and number of new species. Present indications are that Tawi Tawi will prove one of our best islands, if not the best one of the group.

The drawbacks are scarcity of food, and the prevalence of malarial troubles, but we have plenty of provisions and plenty of medicines. From Tawi Tawi we shall return to this place, and I will report again at that time.

Some valuable Moro arms have been presented to us by Spanish officials here in Sulu. We shall make a much more complete collection of arms, articles of dress and utensils of one sort or another before our final leave.

Very truly yours,
Dean C. Worcester.

IV.

Sulu, November 12, 1891.

Your letter of September 11th was waiting for us on our return from Tawi Tawi a week ago, and was very gladly received. On the 9th of October we arrived at Tataan, in the island of Tawi Tawi. The entire north coast of Tawi Tawi is uninhabited, except at Tataan which is a small Spanish military post, kept up merely to maintain their claim to the island. There is a small fort, large enough to accommodate one company of soldiers, who are under the command of a Lieutenant. There is also a Governor, an army Captain, who combines the office of Governor, "Commandante" of the post, Administrator of the Post Office, Captain of the Port, and I cannot say how many others. The present incumbent is a very genial grayhaired Spaniard, who treated us kindly during our stay and showed us every courtesy. Outside the fort stand the house where the Governor lives, the house formerly used by him, which fell to our lot during our stay, and the house of the official interpreter. Scattered over the neighboring hills are a few small clearings where some poverty-stricken Moros cultivate wild rice. They are without exception escaped slaves, and come from Balinbing, a pirate settlement on the opposite side of the island. Dependent on Spanish protection, they are entirely harmless, so that there is no danger in hunting near Tataan. The Governor and Lieutenant above mentioned, with a European Sergeant, are the only white men on this great island. The southern coast has always been notorious as a refuge for pirates. There are several settlements there at present, of which Balinbing is perhaps the most noted, but all the places are under the surveillance of Spanish gunboats, and as the only path across the island, which runs from Tataan to Balinbing, has fallen into disuse, we felt perfectly safe.

The house we occupied was a large one, made in the usual way, and containing but a single room. Fifteen minutes' walk brought us into virgin forest. Our first few days of work were disappointing, as we had hoped to strike an entirely new set of birds in Tawi Tawi, and it seemed as if they were going to turn out to be identical with those of Sulu. But as birds that were extremely rare in Sulu, so that we could not get satisfactory sets of duplicates, were very common here, we felt that we could put in our time profitably. Some very pleasant surprises awaited us, however. The first was a pigeon, of the genus Ptilopus. There are several "bloody-breasted" pigeons in the Philippines, but this one differs strikingly from all the others in having a beautiful orange spot on the breast, in place of the usual red one, as well as in the coloring of the back. It is a magnificent bird, and we decided at once that our trip to Tawi Tawi was a success, even though we got nothing else.

We did not have to remain content with this bird, however. There are three species of "racquet-tailed" parrots known from the Philippines. They are rather closely allied, and distinguished by the shade of green, the amount of blue on head, etc. Well, I shot what I supposed to be the Sulu "racquet-tail." As my man picked it up I noticed what seemed to be a great blood spot on the back of its head. This surprised me greatly, as I had killed it with fine shot, and had been particular to fire when its head was concealed by a branch. Closer examination showed that what I had supposed to be a blood spot was a bunch of red feathers, squarely in the center of the blue spot on the head. It is a most singular modification, and it seemed at first as if it must be a freak, but this red blotch is universally present on the heads of male birds, and the new Prioniturus from Tawi Tawi is the most remarkable, as well as the most beautiful, species of this genus yet discovered in the Philippines. We were able to secure a good series of specimens in fine plumage.

A few days later I went to what is known as "the big river," some six or eight miles inland, to hunt for kingfishers. I expected to find Ceyx argentata, or some closely allied species. I did find a new red Ceyx, and also, to my great surprise, a new Alcedo. Both of these are fine birds. The red Ceyx resembles, in a general way, the red Ceyx from Basilan, though sufficiently different in coloring to leave no doubt whatever of its being a different bird, but the most remarkable thing is the change in habits. The Basilan bird is strictly a woods bird, subsisting entirely on insect food, and never found along streams. The Tawi Tawi bird is invariably found along streams, feeds on crabs and shrimps, and is so reluctant to leave the water that it is comparatively easy to shoot one after once seeing it. The Alcedo was a great surprise. Only one species, Alcedo Tengalensis, has hitherto been known from the Philippines. This ranges over the entire archipelago, and occurs in Tawi Tawi. I was so much surprised to find this new bird there that I marked the first few specimens "Ceyx" in spite of appearances; but I saw enough of the bird and its habits before leaving to satisfy me that it is a true Alcedo. We got good series of both these fine kingfishers. We also obtained a single specimen of a new black and white pitta. This was killed at the very close of our stay by Mateo, and he got so excited when he saw it that he shot it very badly, and I was obliged to make an alcoholic specimen of it. These are birds of which we can speak with considerable certainty.

We also have the following: A sunbird most resembling Cinnyris Juliæ, of Basilan, but differing from any specimens we ever secured in the greatly increased amount of red on the breast. It is probably distinct, but may be only a variety. An oriole, resembling Oriolus Sturii, of Basilan, from which it differs in having under-tail coverts invariably streaked with black Only one of the specimens we obtained in Basilan was so marked. It also has a gray throat, not seen in Basilan birds, and a rather brighter black, probably a variety. A Phabotreron, somewhat resembling Phabotreron amethystina, from which it is however readily distinguished. This may prove to be a new species. A kingfisher identical in coloring with Halcyon Winchelli of Basilan, but differing constantly in form and size of bill. We do not know what to make of this bird. A kingfisher which greatly resembles the beautiful Halcyon coromanda of the north and east, with which it may prove identical. I am not prepared to say, as we have not seen a specimen of H. coromanda for more than a year. In any case we have secured some fine specimens of a very valuable bird, not hitherto known from the southern islands. A kingfisher resembling Halcyon pileata, probably identical with it, but the latter has previously been known only from Balabac. We got only two specimens of H. pileata during our year's work before, and I do not remember the bird with sufficient distinctness to feel sure.

In general I may say that we confined ourselves to the rare and interesting birds, and let the common ones go. We obtained a starling, probably Sturnia violacea, of which we could get no specimens before. We got a splendid series of the beautiful Aethopygia that we first found here in Sulu. We obtained a fine series of specimens of the small blue Ceyx which has puzzled us so much, varying from a bird with brilliant deep-blue back to one with a silver-gray back and no blue on it at all. This is the most remarkable variation I have ever observed. Other fine birds we have in abundance. We obtained in all nine distinct species of kingfishers from the island, besides several varieties. Luzon is the only other island known to possess as many, and the list has been completed there only by years of work by half a dozen different naturalists.

We put up four hundred and eleven skins. Mr. Bourns was ill during the first eight days of our stay, otherwise the number would have been larger. We could not get the slightest evidence that the island had ever been visited before. We were able to record eighty-nine species of birds. We never did so well in this respect before, either on our former trip or on this one. Our nearest approach was in 1888 in Samar, where five of us recorded eighty-five species in one month. Samar, like Tawi Tawi, had not been previously visited.

Wild hogs are so abundant as to give us fresh meat nearly every day. Deer are entirely wanting. In this respect Tawi Tawi differs from Sulu, Basilan and the northern and central islands, and resembles Balabac and Palawan. The difference is difficult to account for.

I now come to the curious mammal of which I enclose description. Shortly before we left for Tawi Tawi the Jesuit priest here, Padre Marche, informed us that just before our arrival he had made a trip to Tawi Tawi, and had bought of the Moros there a curious animal. He said it had the face of a bear, the hands of a monkey, moved like a sloth, and was called "cocam" by the natives. He sent it as a gift to Padre Sanchez, the priest in charge of the Jesuit museum, in connection with the college at Manila. I believe nothing of this kind has been found in the Philippines before, and it makes an important addition to the rather meager list of Philippine mammals. It is evidently one of the Lemuridae, but as generic characteristics are not given in the book I have, I cannot go farther.

I am very sure the creature is nocturnal. We had a hard time to get a single specimen, but I have got track of a place where it is abundant. We expect to return to Tawi Tawi, and may obtain additional specimens. I partially skinned the specimen we have and then preserved it bodily in alcohol, so that the skin can be saved and an anatomical study made if desirable.*

Thursday, November 26, 1891.

We find it impossible to reach Cagayan de Sulu at this time, as the steamer stopped there coming down, and will not do so going back. We can however reach this island readily and more cheaply from North Borneo, later on, so it will make no difference in the end.

We shall arrive in Manila a month sooner than I expected unless the Calamianes should prove rich enough to warrant a two months' stop. I shall probably write next from Manila.

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*Description published in Zoologischen Anzeiger, No. 389, 1892, by Henry F. Nachtrieb.

We have been unfortunate in the matter of our pictures of the "cocam." They had to be instantaneous, with one exception, and we misjudged the sun, and took them too early in the morning. I enclose one picture, which shows the creature asleep.

We have passed the time very quietly since I wrote the first part of this letter. We have killed a fine female deer, and a good wild boar, as well as some birds, but have spent most of our time in attempting to photograph Moros and learn as much of their beliefs and customs as possible.

The former task has been a most difficult one. They believe that they are sure to die soon if their pictures are taken, so we have to steal most of them. Instantaneous pictures can be taken only between eleven and one, at this time of year, and it rains at that time three days out of four.

As regards information concerning their beliefs, customs, etc., we have been most fortunate. We got into the good graces of one of the Moro dignitaries in attendance on the Sultan, and he was very glad to trade us the information we desired, for tales concerning the wonders of America. We have learned things in this way that we could not possibly have learned in any other. In fact, he has told us one thing which a Moro is forbidden to tell on pain of losing his head. I think we shall be able to give you some interesting facts concerning the Moros, on our return, and to show you some pretty fair pictures, as well.

We expect to sail for Paragua in the morning. We are well rested, free from fever, and ready for hard work once more.

Very truly yours,
DEAN C. WORCESTER.

V.

Puerto Princesa, Palawan, P. I.,
January 26, 1892.

As Mr. Worcester is at present very busy with other matters and the time before the closing of the mail is limited, he has asked me to write you, giving some account of our work in the island of Palawan.

We arrived upon this island December 1st, and had no trouble in finding a good house near the edge of the town, where we were soon established. Our first work was to care for four specimens of Tragulus obtained at Balabac while the boat stopped. We secured in all seven specimens, of which we now have three in the form of skins and four as skeletons. They were all obtained by exchange, we giving a few ordinary but brightly-colored birds for them. We were very fortunate in obtaining these specimens, as this little deer does not exist in Palawan and we were unable to stop at Balabac beyond the usual halt of the boat.

The month of December was spent here in town, collecting all the birds we could get. We were very successful, as we obtained 550 specimens, of which we used in exchange for various things, probably fifty.

This month we have also obtained some birds, so that in all we have something over 600 specimens, of 99 species. Of these 25 were not obtained by us on our first trip, but we now fail to get eleven that we previously captured. Most of these however are water birds of wide range and little value. The only valuable birds that we know of, not in our present collection, are two hornbills. We were fortunate in getting a very fine specimen of Polyplectron napoleonis, or, as it is called here, the "royal peacock.' On our previous trip we were unable to obtain a single specimen, while now we have at least a dozen males in fine plumage and an equal number of females. The male of this species is probably the most showy bird found in the Philippines. Among other rare birds obtained are, Aethopygia Shelleyi, Arachuthera dilutior, Prionochilus Johannae, Zeocephus cyaneiceps, Tiga Everetti. As to new birds, we cannot write definitely as our list is incomplete, lacking some thirty species. We have one bird from the mountains that interests us greatly. It is a small, nearly tailless, brush or ground bird and the single specimen we have was caught in a lasso set for the royal peacock.

At the end of the first month's work, having a good set of birds of the island, we set out for other parts, to follow up reports that were brought us of a mountain goat and a very large monkey. We also hoped to be able to get more of the mammals of the island than we could get by staying in town. So on New Year's day we started, in company with a Spanish friend and a number of Tagbanna (native) carriers, for a small settlement named Tagbaroos, situated about ten miles up the coast and quite near the mountains. The natives of Tagbaroos had reported to us that at a distance of a day's march from their town there existed a mountain goat. As their knowledge of the animal was very slight and we greatly doubted the existence of the animal, we sent our trusted hunter, Mateo, in advance to see if he could find any evidence. Mateo is the Malay who returned to America with Dr. Steere in 1874 and was afterwards his chief hunter here. He was gone three days and a half and reported that there was no evidence whatever of the existence of a goat in the region he visited; in fact, the country was not suitable for such an animal.

Upon the receipt of this news we decided to divide our forces, one remaining in Tagbaroos to take care of the peacocks, squirrels, wild cats, etc., that were being brought in daily by the natives, and the other going back to Puerto Princesa and from there across the bay to another native village, called Igwahit, to start the people there also on a hunt for birds and mammals. At the end of a week's time we were to unite in Puerto Princesa, to get our home mail and then start out together for Igwahit. This plan we carried out. The lot fell to Mr. Worcester to go to Igwahit, and with Mateo and one servant he left on January 5th. During my stay in Tagbaroos I was kept fairly busy with peacocks, animals, etc., and felt fairly well satisfied with the week's work.

On arriving at Puerto Princesa on January 10th, I found Mr. Worcester already there and was delighted with his account of operations across the bay. He reported that the natives had taken hold of the work in earnest and the village was engaged in setting snares or hunting animals. For two days both he and the two servants had been busy from morning till night, when a native came along and reported that they had captured a large snake and asked if he would buy it. They were in the woods hunting for porcupines and had found this snake in a hollow log and had, with great trouble, captured it and dragged it to the nearest house, where they had it tied to the posts beneath the house. After a very few questions Mr. Worcester perceived that if the snake was as large as they reported, it was an exceedingly valuable specimen, so he immediately agreed upon a price and early next morning with a servant he set out for the house.

On his arrival at the house he was pleased to find that the snake exceeded by six inches the length given by the man, actually measuring 22 feet and 6 inches in length by 24 inches in circumference. With small trouble the powerful animal was chloroformed and then killed. Then came the task of skinning it which was no small one, I assure you. But the work was done, the skin taken off, carried to camp, cleaned and salted before dark. The weather was so favorable that by the end of a week it was well preserved.

We congratulate both the Academy and ourselves on having obtained a snake of this size. That snakes even much larger than this exist here there is no doubt, but we have now spent nearly two years and a half in the tropical jungle and never before have we seen a snake that even approached this one in size. In Mindoro we secured one thirteen feet and eight inches in length and, although we hoped, still we never expected to get one over twenty feet long. But the snake was not the only thing secured at Igwahit. Together we went there the day the mail arrived, and all of that week we were busy putting up birds and animals. Some of these are worth notice.

1. The flying squirrel (Pteromys), of which we obtained thirty-two skins and some skeletons. This squirrel, of which we heard accounts in 1887, is a very pretty animal, a typical flying squirrel, from twenty-two to twenty-eight inches in length, varying to almost pure white. In most cases we have preserved all the bones, so that skeletons can be made in case they prove more valuable than the skins.

2. The ordinary squirrel, Sciurus Steerii, of which we have a number of skins, etc., and some specimens in alcohol.

3. Tupaia (sp.?), known here as the besin. It is abundant and we have a number of specimens.

4. A species of Histrix. In 1887 we obtained a single mounted specimen of this porcupine, by exchange in Manila. We now have seven skins and three complete skeletons, besides most of the bones to go with the skins.

5. Six skins and one skeleton (besides extra bones) of the "pantut."* I can give you no other name for this curious animal. In general appearance it resembles a huge mole. Its fur is very dark brown, almost black, and quite glossy. The legs

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* Mydacus Marchei Heut, is the name standing in Occasional Papers, vol. 1, p. 61, Preliminary Notes on the Birds and Mammals collected by the Menage Scientific Expedition to the Philippine Islanks, by Frank S. Bourns and Dean C. Worcester, 1894.

are short and the feet are armed with long claws for digging, the claws of the front feet being much the longer. The eyes are small, the ears inconspicuous and the tail almost lacking. The snout is very like that of a pig, and from what the natives say, the animal gets its living in much the same way as does the pig. The most noticeable feature of the peculiar animal I have not yet described nor can I. It is the odor, and it is fortunate that I cannot so describe it that you can get an idea of what it is. It is powerful and comes from the liquid contained in two small sacs placed just under the bones of the rudimentary tail. The natives here say that this animal, with its powerful odor, has driven out of the island both the deer and the little Tragulus. This of course is a mere superstition, as we know that both Tragulus and the pantut exist in Balabac. Most of the specimens that we have were caught in lassos.

6. The "manturong," of which we have a single specimen. This also we are unable to classify. The body is covered with coarse hair of a dark gray color. Eyes dark and bright, ears tufted and small, tail long and very broad at base. The head resembles that of a raccoon. Unfortunately the animal had broken off most of the front teeth, so that we could not get a good idea of the dentition.

7. A rare specimen of the melu (Paradoxurus philippinensis). We have specimens from most of the islands visited. Here we have obtained one that differs from all others we have seen in being pure black, the color usually being brownish.

Of most of these animals we have a good number of specimens. Also we have alcoholic specimens of the whole animal, or of parts of it.

The only animal of importance we feel sure exists here, which we did not get, is a species of cat which, from the description given us, is very much like the one we obtained in Panay and Negros.

As already mentioned, stories were told us of the existence of two other animals, a mountain goat or, as they called it, "manda rata," and a large monkey or "pakduh," and it was to prove or disprove these stories that we put in the last week of our time here. The whole country round about is mountainous, the highest peak near Puerto Princesa being called Pulgar. The Spaniards in the town informed us that the mountain had never been climbed and was inaccessible, that various atttempts had been made, but that no one had ever succeeded in getting a third of the way to the top.

The natives also said that the mountain had never been climbed, even by their own people, but they gave us the reason, the fact that the "pakduh" or large monkey lived up near the peak, and they were afraid to go up there. We did not have much faith in their stories, but the opportunity was a good one, for determining the existence both of the "pakduh" and of the "manda rata," or goat, because if the goat existed at all in this part of the island it would very likely be on this wild mountain.

So it was that we decided to make an attempt to climb Pulgar. The details of the ascent probably would not interest you. Mr. Worcester started on a day ahead and established a camp at an altitude of 2,000 feet, the highest point ever reached by the natives. There I joined him the following day and the next morning we set out for the peak. One man with a large woods knife went ahead to clear a path and others followed carrying blankets, provisions, etc. It was hard work, but was by no means so bad as represented, for by two o'clock P. M. we were at the summit. Our success was undoubtedly due to our good fortune in striking a ridge, which we were able to follow to the very top. On all other sides, with possibly one exception, the mountain appeared to be inaccessible. We spent the rest of that day and a part of the next on the peak, but failed to discover any indications whatever of the existence of goat or monkey.

The monkey is undoubtedly a myth, and although it is possible that the goat exists in the northern and more rocky part of the island, it is certain that it does not exist on Mt. Pulgar, nor could it. The mountain is very rocky but is entirely covered with vegetation, which, although stunted at the top, is thick, almost impenetrable to such an animal, and not at all suited to it.

We should like to visit the northern part of the island, as, from all accounts, it is quite different from this part, but are unable to do so. The steamers do not call there and at this time of the year it is almost if not quite impossible to make the voyage in a small boat.

Our trip to Pulgar was not without some results however, as we were able to secure a good collection of ferns and mosses.

As the mountain has never been visited before it is not improbable that there are new species in the collection.

We also found a number of species of shells that we had not obtained below, some of which may possibly be new.

We have in all over 650 specimens, of about 17 species, of which about 150, of 14 species, come from the mountains, the remainder of three species, being the common shells found about the town.

We also obtained a few butterflies while at Igwahit. Among them we have five specimens of a very rare and beautiful species. A German collector who is now here values it so highly that he considers it a good week's work for one of his hunters, if he can catch a single specimen.

We are now awaiting the steamer to take us to Culion, an island situated between Palawan and Mindoro. It is one of a group called the Calamianes. Very little is known about its fauna and we can get no information except that shells are abundant and a species of deer exists there. The largest island of the group, Busuanga, is wooded and it is not improbable that we shall cross over to it. We hope to find something new or interesting during our proposed month's stay. Thence we shall go to Manila, from which point Mr. Worcester or I will write you again.

Yours very truly,

F. S. Bourns.

VI.

Calapan, March 8, 1892.

Since writing you last we have been in Culion and also a week in Manila. Our time in Culion was very short, three weeks of working time. We found very little forest, and that of poor quality and hard to work. The birds and mammals are very similar to those of Palawan. Among the birds there were varieties that, in some cases, might be marked enough to form new species. We cannot say that we have them new however, as, much to our surprise, we learned that the French naturalist, March, was there in 1885.

After a week's work near the town we moved to the centre of the island and for ten days occupied a small native house. Here we hunted birds with poor, and deer with good, success.

We put up fourteen skins of animals of both sexes and all sizes. We never saw anything equal the abundance of deer. We killed them with rifles and with shotguns, and caught them alive with dogs, and one of the party actually succeeded in catching a very young fawn, with his hands alone.

All told we got about 140 birds. An interesting mammal captured was a fine specimen of the Manis, a scaly ant-eater. It is identical with the one found in Palawan. We were able to get only a single very poor skin of native preparation. We secured two specimens of a squirrel which we never before obtained, but presume Mr. March got it before us. We also gathered a number of land shells of good species. Some are identical with Palawan forms, while others are peculiar to Culion or rather to the Calamaines group.

But by far our best success was with large snakes, of which we got two. The first, which is also the larger, we caught while in the interior. We had been told many stories about large snakes, so when we got among the savages we offered a substantial reward to anyone who would find and show to us a large snake. Soon after our arrival, two savages came to the house and said they were ready to take us to the "house" of a big snake, not over a mile and a half away. So we prepared ourselves for work and set out. We were conducted to a large hollow log, lying on the bank of a small stream, and through a crack in the log, we could see a portion of two coils of what seemed to be a snake 16 or 17 feet long. We stopped up both ends of the log, enlarged the hole near the snake, and after some trouble, succeeded in getting several strong rattans around the animal's body. Then the hole was still farther enlarged and we began to pull. That caused the snake to move and we soon saw that we had a larger one than we at first supposed. At first the snake braced the coils so that we could not stir it but finally the strain on its neck became so great that it relaxed its coils and with a rush it was hauled out into the bed of the brook. It was not at all active, so, after admiring it for a few minutes, we killed it by a knife thrust into the heart. It measured 22 feet and 8 inches by 22 inches in greatest circumference.. In the log we found a mass of 89 eggs which the animal had been covering.

It took us the rest of the day to skin it, but by dark we had the skin at the house. The next day we returned and cleaned the bones, so that we have both skin and complete skeleton. ,

The day we left Culion a snake 19 feet and 11½ inches in length was brought in. We had just started to skin it when the boat came in, so we were obliged to take it on board and skin it there.

We considered ourselves very fortunate to obtain a large snake in Palawan and never expected to get another of the same size. We were therefore very much pleased to obtain two more skins and a complete skeleton for the Academy.

During almost all the time in Culion we were very much handicapped by the fact that Mr. Worcester was troubled with his eyes. What the trouble was we do not know, nor could the doctor in Manila inform us. This trouble prevented him from doing any outdoor work, with the exception of one day on our arrival, and the two days when we were working on the snake, when he went out, against his better judgment. I am pleased to say that he is now much improved and expects to be well in a few days.

We spent a week together in Manila, during which time we were very busy indeed. We had occasion to call on the Governor General, and were very courteously received. The readiness with which the several requests we had occasion to make were granted was very gratifying.

We were unable to finish all of our business in the week before the semi-monthly steamer left for Calapan, so Mr. Worcester stayed to attend to it. He will go to Batangas by steamer and then cross to Calapan by small boat, reaching here five or six days later than the steamer.

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With regards to all, we remain

Very truly yours,

F. S. Bourns.

VII.

Manjuyot, Negros, May 21, 1892.

You may perhaps remember this as the place where the people catch pearly Nautili in deep-sea traps. It is, so far as I know, the only place where they are trapped, and when I was here before I was informed that May was the only month in which they could be obtained to good advantage. Since then we had shaped all our plans with a view of getting back here at this time, and it is needless for me to say that to date we have not preserved any specimens, though I hope soon to do so.

The statement that the pearly nautili can be taken only at this time seems to be untrue, as the inhabitants here say they took fifty odd in a few days' time, some four months ago, and ate them. A lot of fine fresh shells are shown in evidence. They seem to have no doubt of being able to get them now. I arrived here day before yesterday and already have everybody setting baskets. It is now too soon to hear from them.

I hope also to be able to obtain specimens of the wild cat, but cannot expect to do much else, as there is no forest within reach. I may possibly be able to get a number of species of land shells through business men who have natives at work in the mountains of the interior.

Our trip from the time we left Mindoro until Mr. Bourns reached Cebu and I got here to Manjuyot was unexpectedly short. We reached Manila in the afternoon of Monday, May 9th, and left again the following Saturday morning. During our short stay in Manila we had to repack nearly all of our collections, as we had been unable to get good cases and barrels in Calapan. This, with the work of shipping our collections and arranging an exchange with the Jesuits, made every moment more than full. Indeed, we were obliged to spend nearly all of the last night before our departure in the work of packing our equipment and supplies in order to get away.

On my arrival at Iloilo, where I had planned to spend several days, I found there was but one steamer making the run to Bais and that left in the afternoon, so I had to make another desperate rush.

We took upon ourselves the exchange of a timaran with the Jesuits, for material from their museum. They have always been very kind and courteous, and in several instances have rendered us service of great value, notably when we were having trouble with our things in the custom house on our arrival here. They have been very anxious to get a timaran, and as they had much material valuable for the Academy's collections from these islands, we felt that an exchange could be made to good advantage to both parties. The specimen we gave them was an old bull, and perfectly preserved, yet I am sorry to say it was somewhat torn by bullets, being shot through both the head and body.

They gave us in return a collection of two hundred and fifty species of shells, mostly sea shells. We do not set a high value on this collection as most of the species are common, but it will help a good deal when it comes to the identification of the shells we have already sent home. Our exchange was chiefly for arms, implements, ornaments, articles of dress, etc., of savage tribes, largely those of the interior of Mindanao. We also obtained four wooden idols, from the same region. A good many of the articles in question are not to be found except in this collection of the Jesuits. We are to receive, also, a collection of land shells, and to take such specimens as we desire from their set of Philippine birds' eggs. We did not have time to complete the exchange, nor to pack the material. Everything is securely stored however and will be sent home when we reach Manila.

In addition to the foregoing we got a fair set of birds, small but good, including a single specimen of a sunbird which is entirely new unless obtained by Dr. Platen at the time of his visit, and this is, I think, improbable. We secured a fine lot of Mangyan material, including a partial skeleton with a good skull of a man, and a woman's skull in excellent preservation. These were obtained in deserted houses and may be of some ethnologic interest.

We found two very rough images cut out of soft stone by the Mangyans. They were in the woods, near the shore of Nanjan Lake. One was erect, sitting on a large boulder. The other was lying on the ground with its head broken off. What they were made for we could not learn. We appropriated them. We send a bow and poisoned arrow. The latter should be treated with respect.

Two large python skins were sent in the last shipment of material. One is dry, the other in one of the barrels with timaran skins. The skins of a cow and a calf timaran were utterly ruined, owing to natives getting too ambitious, and killing three timaran in one day. We threw the cow skin away, saving only the skeleton. The calf skin we sent, as the taxidermist may want to use some of the hair from it, and it took up little room.

The other skins are strictly first-class in every way, and much more valuable than the dry skins we sent before. This shipment was by the "Jennie Harkness," an American ship bound for New York. If she makes the trip in 150 days, starting at this time of year, she will do well. Like the last ship, the "Jennie Harkness" goes to the National Cordage Co.

Stirred by our success, the Spaniards have made two attempts to get timaran in Mindoro. One of them failed utterly, and the second seemed in a fair way to, when we came along.

Wednesday, May 24. I am very glad to be able to report that the stories about pearly Nautili at this place prove to be entirely true. The natives brought in two night before last, five last night, and my only fear now is that they will bring them in faster than I can preserve them. I wish I knew how many could be used to good advantage, but shall have to use my own judgment in the matter.

Sincerely yours,
DEAN C. WORCESTER.

VIII.

Toledo, Cebu, June 25, 1892.

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Mr. Bourns is at the present moment quite busy with one of the attacks of fever which we have come to consider a part of the regular order of things. I hope however that this will be a light attack of short duration, as is usually the case. The fever which has troubled Mr. Bourns, Mateo, and one of our boys was undoubtedly contracted in Mindoro. Personally I was very fortunate in being ill but once while there, and have had no return.

* * * * * * *

Work, since our arrival in the island of Cebu, has been most satisfactory in its results. Mr. Bourns arrived here sometime before I did. He found that the beautiful strip of forest in which we had expected to work had been entirely cleared off during our absence. He spent most of the time before my arrival in scouring the country on horseback, searching for a favorable place to work, and succeeded in finding one just before I arrived.

We are quartered in a small native house, or rather hut, where we suffer much inconvenience from our confined and narrow quarters, being obliged to eat and sleep in the one small room where we skin and dry our birds. We are near the forest however, which is the chief desideratum. Good food is abundant and cheap, and we are greatly indebted to Mr. Pickford, an English sugar planter living near by, for much kindness received. Mr. Bourns stayed with him before my arrival, and we have a standing invitation to come to his house at once if we get run down, and stay as long as we like.

The number of species of birds known to exist in this island before our arrival was fifty-five. These might well be divided into two groups. One, including nearly all the species, consisted of the very common birds frequenting the open fields and groves of palms in well cultivated country. These are worthless to us now, as we have all the duplicates we can hope to handle, the species being nearly all widespread.

The other group included a few peculiar birds found about the year 1876 by an English naturalist. From that day to this no one has been able to rediscover them. We had never even seen specimens, and knew them only by name.

We have found almost every known species, including all of the rare ones but one. The latter is a small owl, of which the only specimen known was shot by myself when we were here before. This can be obtained only by accident.

We have also found just forty species never obtained in this island before, and this in spite of the fact that the island has been visited by nearly all the naturalists who have worked in the Philippines.

We failed almost completely to get the birds we wanted on the occasion of our visit in 1888, and so are the more rejoiced at our success now. This will prove one of the most valuable sets of birds obtained by us, not only because the species are rare or unknown at present, but because it is probable that within ten years the last bit of forest will have been cleared from this island and many species will become extinct. I think we got here in the nick of time· We cannot pile up the number of specimens as rapidly here as in some places, for it is rough, hard country to hunt through, and birds are scarce, but those we do get are worth having.

I may say, also, that we are "on the trail" of another big snake. He is reported to be a foot in diameter when not gorged with food, and we have offered ten dollars for him if he comes up to contract size. This would break the world's record, and if we should get it you had better send it to the "World's Fair." I think you would capture first prize. It is very doubtful if we get him however, as he hides in caves and the natives are not over anxious to crawl into dark holes to look for him. I cannot honestly say that I blame them.

Personally I do not fear the big snakes half so much as I do the venomous ones. A beautiful specimen of a species, the bite of which is said to be fatal in an hour or two, has just been brought in. These creatures give us the crawls always, when we get hold of them, and we are half afraid to go into the woods for a week afterward, but soon grow indifferent again. I had hoped there were none here, and was not so glad to see the specimen as I ought to be from a strictly scientific point of view.

We are glad to know that the Academy is pleased with the big snakes already sent. They ought to make something of an attraction when well mounted. I hope the first skin is in Minneapolis before this.

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Yours very sincerely,
DEAN C. WORCESTER.

IX.

Manila, September 1, 1892.

We are once more in Manila unpacking, repacking, shipping and generally preparing for another period of work in the "provinces." For the last two months, or since we wrote you last, we have been at work in Cebu and Samar. When we wrote we were very much in doubt as to the length of our stay here, but since then we have received a letter from Mr. Menage, in which he informs us that he has agreed to our proposition to extend the time of the expedition for eight months. This is very gratifying to us and we fully appreciate, as must the Academy also, the generosity shown in thus enabling the expedition to complete the work. As members of the Academy and of this expedition we feel that we are very fortunate in having so liberal, public-spirited and staunch a supporter as Mr. Menage. We hope and expect that the results of the work will fully justify the heavy outlay involved.

Our work in Cebu resulted very satisfactorily. We succeeded in reaching fairly good woods, and secured a good set of birds.

As there remains very little forest in Cebu, birds are difficult to obtain and some have not been found since their discovery years ago. We were very much pleased, therefore, to get good sets of such birds as Phyllernis flavipennis, Oriolus assimilis, Prionochilus quadricola, etc. These birds are even now rare and valuable, and as time goes on they will become more so because the forests of Cebu are rapidly disappearing and in a few years will be gone. We obtained two or three that are probably new, and some others that, although not new to us, are new to science, being identified with new species before obtained by us in Negros, Panay and Siquija. Among these are two small kingfishers of the genus Ceyx and a small sunbird. Another interesting find was that of Aethopygia magnifica. This, one of the most beautiful of the sunbirds, was discovered by Dr. Steere in 1874, in Negros, and up to the time of our arrival here was supposed to be confined to that island. As we wrote at the time, we found it in Panay in October of 1890, and now we find it in Cebu. It seems quite strange that it should have escaped notice in Panay and Cebu from 1784 to 1890, and we are very glad that we have been able to add it to the fauna of these islands.

We are able to report also the existence in Cebu of the "maral" or wild cat, of which you have several specimens in your possession.

On our arrival in the city of Cebu we found awaiting us a fine lot of the Venus' flower basket, Euplectella, which had been collected in compliance with orders left by us some weeks previous.

In Samar we were also quite successful. It was from Samar that so many new birds were obtained by the Steere Expedition in 1888, and as very careful work was done at that time we had very little hope of new birds. But as the birds from Samar are very valuable, we went cheerfully to work, and in order to be near the woods built a small house near the hills, a distance of three or four miles from town.

Living thus on the edge of the woods we were able to get an early start each morning and to spend a longer time in the woods than is usually the case. We were thus enabled to get a large, though not a complete set of the known birds. Two or three of the birds that we desired escaped us. When we were here in 1888 there were many trees in blossom or fruiting, and from these we could frequently get birds that are usually very difficult to obtain. This time the trees were not fruiting, and that advantage was lost to us. We did obtain however three birds that we feel sure are new, and this more than repaid the loss of the known birds. We were enabled to add several to the known list of Samar birds.

An unusually good set of the large hornbills from Samar, including both skins and skeletons, was secured. Our good fortune in capturing these birds was largely due to the discovery, by our Philippine hunter, Mateo, that these birds will answer to a call. The call is an imitation of their own note, being a short "haw" given in a deep bass and very short. It was very amusing to hear the replies of the birds and see them come flying down to find out the cause of all the disturbance. We also secured a good series of the smaller hornbill Penelopides.

On our arrival in Manila, we made the exchange with the Jesuit Museum and secured a fine collection of shells, Moro arms and utensils, native idols, charms, etc. We were much pleased to get hold of this material, as most of it is very valuable and difficult to obtain.

We have just made another shipment of sixteen cases, four kegs and one bundle. You will find in this shipment the birds collected during the last three months; alcoholics, including all of the specimens of the pearly Nautilus collected by Mr. Worcester in Negros; the Venus' flower basket from Cebu; a large number of land shells from Negros, Cebu and Samar; all of the material obtained by exchange; a lot of bows, arrows, etc., from Mindoro and Culion, and a collection of pottery purchased in Manila. The shipment is a valuable one and will interest not only the members of the Academy but others as well.

It was our intention, when we reached Manila, to go directly to North Luzon and the Babuyanes and Batanes islands; but we learned that during the rainy season we could not work to advantage, so we were compelled to change our plans entirely.

Mr. Worcester, with Mateo, goes to Romblon, Sibuyan and Tablas, then back to Manila and down to Culion and, about January first, up to North Luzon and the adjacent islands. I go to Sulu, Tataan (Tawi Tawi), Cagayan de Sulu, and then without returning to Manila cross over to Singapore and into Borneo.

In this way we are enabled to avoid the worst part of the rainy season and cover the ground we desire.

It is of course not so pleasant this way, as we are compelled to be alone. But the work required it, so we made the change. I don't expect to speak English again until I reach Singapore in December.

I shall write to you from time to time, as will Mr. Worcester, so you will be posted as to our work.

Yours very truly,

F. S. BOURNS.

X.

Romblon, October 23, 1892.

I am waiting for a steamer for Manila which will very likely arrive before I can finish this letter; but I will at least begin. Mr. Bourns wrote the last letter we have sent you, from Manila, just before we separated. Since that time I have visited the islands of Romblon, Tablas and Sibuyan.

I arrived in Romblon seven weeks ago to-day, and was very shortly in a comfortable house. Romblon is an island almost entirely under cultivation, and I had not hoped to be able to do much here, expecting merely to make it a base of operations in visiting Tablas and Cibuyan. A steam launch left for Cibuyan shortly after my arrival, but I could not take it, as it was necessary for me to make my usual call on the Governor, and there was no time to do so before the launch left. A heavy storm of wind and rain set in at once, and lasted with little interruption for two weeks. The launch was unable to get back from Cibuyan, and I was stranded here.

I was able however to put in my time to much better advantage than I had expected. There is one bit of forest near the town, and we were so anxious to see what could be found that we hunted without much regard to the weather. The first day's work resulted in the discovery of two new birds, a "fruit-thrush"* and a flower pecker."† These were the only new birds we got, but we shot a good many old ones that were well worth having. We are well pleased, in these days, with an island that gives us even two new birds. We found forty-five species here. These three islands are famous also for their land shells, and this wet season is the very time to get them.

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*Iole cinereiceps B. & W.

†Dicæum intermedia B. & W.

I shortly had all the small boys of Romblon in my service, and during our two weeks' stay made a large and, I think, a very complete collection of the land shells of the island. In Tablas and Sibuyan we made fine collections of shells also. We have about eight thousand specimens.

The shells are brought in alive, a few at a time. To sort out the good from the bad, bargain for the good ones, kill the animals and remove them from their shells, wash the shells, and then wrap each one in paper, and pack them all, has been a good deal of an undertaking. The shells are a very fine set, right through, and as we got none of these species when in the Philippines the first time, I think they will be valuable to the Academy, both for exhibition and exchange. Each of these three islands has its own set of shells.

Just two weeks from our arrival in Romblon, we left for Tablas, on the steam launch. We established ourselves in a town called Badajos. The forest was conveniently near, birds and shells were abundant and we put in two very profitable weeks. We were fortunate in having uninterruptedly fine weather during our entire stay. We found immediately two species of birds of great interest. One is a new Diarurus,* the other a flycatcher. I am not prepared to say that the latter is new, as there has been a species of this genus, Philentoma, recorded from the Philippines for some years, and while I have never seen a specimen of the bird, nor a description of it, the name fits, and I am inclined to think that we have found out at last where "Philentoma cyaniceps" came from. If not, a fine new species of the genus is discovered. The two new species found in Romblon are also abundant in Tablas. We shot a single specimen of an owl likely to prove new, and found seventy-four species in all. I have always feared that the birds of this island might prove identical with those of Panay. Prof. Steere felt so sure they would be the same that he did not think the island worth visiting. Fact is better than theory, however. The island differs from Panay not only in the occurrence of a number of species of birds entirely distinct from Panay representatives of the same genera, but in the absence of whole families, as hornbills and woodpeckers, as well as in the absence of deer, which abound in Panay.

We were very fortunate in making connections on returning from Tablas. Arrived in Romblon one evening in a native boat, we left the next morning, in the launch for Sibuyan. The distance from here to Tablas is short, and the passage reasonably safe in the native boats, but it is much farther to Sibuyan, and the passage at this time of the year a very dangerous one for sail-boats of any description. Had we not caught the launch we should have been obliged to wait until it made another trip.

We got to work without loss of time, and shortly found several interesting species of birds. The three which especially attracted our attention are a woodpecker, a kingfisher and a "flower-pecker." We found a magnificent flycatcher which has the colors of Cyanomyas coelestis, but the splendid crest on the head is longer than in any specimen of C. coelestis I have ever seen, and that bird has never been found in any of the islands near these. We secured sixty-four species of birds in all, and they are a queer set, quite different from those of Romblon and Tablas. I should have been glad to remain in Sibuyan another week, but we had to choose between leaving at the end of two weeks and the risk of being stranded for some time, and it seemed best to go.

Since our arrival we have been busy packing our specimens and rearranging baggage preparatory to another trip, so that we may be able to make a quick move in Manila if it is necessary to do so. I now expect to go next to Masbate.

The result of our work for the last seven weeks may be briefly summed up by saying that we have discovered a number of species of birds, possibly new; have made a larger and more varied collection of land shells than we ever did in the same length of time before, and have found what birds and animals exist in three islands where the birds and animals had never been studied before, and concerning which nothing was previously known.

The fauna of this island was probably once identical with that of Tablas, so far, at least, as birds and mammals are concerned. The present differences have been brought about by the destruction of the forest here. The fauna of Sibuyan is quite distinct. All three islands are poor as regards number of species, the difference being apparently made up, in many cases, by the great abundance of representatives of the species which do exist.

Manila, October 30, 1892. Our steamer was four days late in Romblon, and we had to wait all that time with baggage packed, which was exasperating. We arrived here Thursday noon, and leave tomorrow (Monday) morning, having had barely time to do the necessary work here.

We are in the best of health, and hope to rush business in Masbato and Ticao. Shall be back here in five or six weeks and I will then report again.

We very heartily appreciate Mr. Menage's generosity in allowing us the extension of time, and hope that both he and the Academy may be satisfied with the results of it.

With many thanks for your kind expressions and good wishes,

Very truly yours,

DEAN C. WORCESTER.

XI.

Manila, December 8, 1892.

Since my last letter to you I have spent five weeks in the island of Masbate. The month of November is usually the worst in the year here, and this year has been no exception to the general rule. We had one typhoon, rain often fell uninterruptedly for days at a time, the fields were flooded and the paths nearly impassable from mud.

However, we raised the number of species of birds known to inhabit the island from 32 to 102, and made some valuable finds, the best of which is a fine species of Cittocincla entirely new to science.* The discovery of this bird was a great surprise, as I did not in the least look for a representative of the genus in the island. Many of our specimens are both interesting and valuable, and we are now in position to put Masbate in its proper place among the other islands.

I hoped to visit Ticao, but was unable to do so, as the sea remained so rough as to make it impossible to get across. Ticao is a small, heavily wooded island close to Masbate, and probably has the same fauna, but it would have been interesting to make sure.

We made a hard attempt to get specimens of the spotted deer of Masbate, riding clear across the island to reach the place where they are found, but when we arrived at our destination we found the grass where they feed and hide to be higher than our heads, and, though we hunted in the pouring rain for four days, obtained but one young specimen.

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*Cittocincla superciliaris B. & W.

The rain was favorable to the collecting of land shells, and we were very successful, getting a large collection, among which are several large and fine species not previously known from this island. One of our land shells from Sibuyan proves to be new. Unfortunately we could secure only a single specimen, but the Academy will at least have the only one in existence.

I leave day after tomorrow for a second visit to the Calamianes. I hope to be able to reach the forest said to exist in the interior of Busuanga, and to find there some birds we did not find in Culion. I propose to spend several days at first in putting into practice my ideas about securing specimens of big snakes, though I do not care to make any promises as to results. I expect also to visit the Tagbanoa burying caves, and make a collection of skulls at least. I probably shall not be able to report myself for some time, but hope to have good news to communicate. Mateo and I are both strong and in the best of health, and if the weather improves, as it ought to in December, I think we can give a good account of ourselves.

Yours most sincerely,
DEAN C. WORCESTER.

XII.

Sebangan, Borneo, January 12, 1893.

As I am just about to start on a month's trip, away from all mail facilities, I shall drop you a line now. I am much gratified to hear that you feel pleased with the collections so far received. That, when they are all in, they may be satisfactory is the end toward which we are working. As I have already written both you and Mr. Menage about my Sulu and Tawi Tawi collections, I will not repeat much here. There are one hundred and eight cases in all, which I hope you will receive in good condition. The Moro arms, clothes, etc., I did not send, as I had not the collection made when the other boxes were shipped. They are now in Singapore and will be sent with my Borneo collections.

I arrived in Kuching, the capital of Sarawak island, Borneo, on December 17th. By advice of Mr. Maxwell, the Resident of Sarawak, I decided to try the Sadeng River, as the orang-outang (here called the mias) was reported to be abundant there. I left on the first opportunity, embarking on the 23rd on a small coal schooner bound to the Sadeng coal mines. Christmas was spent at sea, pitching about in the schooner. We reached Sadeng on the 26th. A week about Sadeng convinced me that it was not the place for my work, so on January 2nd I loaded all of my goods on a small boat and started for the Sibuyan river. On reaching the mouth of the Sadeng river we met bad weather and were compelled to turn back. Not to lose time, I decided to make a short trip up a small river that empties into the Sadeng almost at its mouth. The baggage was unloaded and put in a small empty house on the bank, and on the 4th, with a light outfit and provisions for a week, I started. That night we reached a Dyak house, where I was very hospitably received. I was presented with a fowl and four plates of rice (one from each family) and in return presented each of the leading men with a little tobacco, with which I had of course supplied myself for this special purpose. Then we talked ordinary orang-outang (mias). The men were of the opinion that a mias might be obtained on a hill, an hour's walk from the house. So I decided to try it on the following day. After another two hours' talk on various subjects, I spread my sleeping mat and tried to rest. Very poor success however, as the floor was hard and the people talked and laughed till past midnight. It is the season of the rice harvest and they were all busy pounding, winnowing and assorting rice.

In the morning, with one Malay and two Dyaks, I started for the hill. The path was through the swamps and was very hard indeed to travel. A misstep sent one into soft mud from one to three feet deep. It was a rather long hour's walk, but we reached the hill at last and began to look for mias. One Dyak went on one side while the other with the Malay kept with me. About the middle of the forenoon we heard the report of a gun, the signal agreed upon, and retraced our steps until we came up with the Dyak. He was following two mias that he had found on the edge of the swamp below. They were in very high trees, but no tree is too high for a Winchester, and soon I had both mias on the ground, dead. They fell with a great crash and the larger one struck so heavily that some of its bones were broken. They were not of the largest size, evidently a young pair just started out, but were in good condition and furnished good skins and skeletons. The following day we continued on up the river to another hill, where we put up a rude shelter as protection against rain and sun. That afternoon one of the Dyaks brought in a female mias, which we skinned next day. The next two days brought in nothing but a tupia, two squirrels and a few good birds. Two mias were seen by the men but were gone before I could get to them. So I decided to return the next day. Early in the morning it was raining, but about seven it stopped; we broke camp and loaded the boats. With two men I started ahead in the small boat and soon ran across a flock of long-nosed monkeys. I gave chase, and wading through the swamp, up to the waists in water, we ran across another mias, which we secured. Farther on down the river I shot two black monkeys, a female and a young one a month old. We arrived at the house about two o'clock, making a quick trip as we were favored by the tide, this being a tidal river.

I found that a large male mias had been brought in by some Dyaks from the Sadeng. It had been killed for at least twenty-four hours, so that my boy, whom I had left in charge of the house, was not able to save the skin. He saved the skeleton, a fine one, in good condition. Had I been on the spot the moment the animal arrived I might possibly have saved the skin by means of a warm salt and alum bath, but it is doubtful, as twenty-four hours in this climate is usually enough to start the epidermis on almost any animal.

This is a brief account of my work up to date in Borneo. I expect to start in a day or two for the Sibuyan river where I hope to get ten or a dozen good mias, besides other mammals of interest. While there I shall be beyond the reach of mails.

With kind regards to yourself and all inquiring friends, I am,

Yours very truly,

F. S. Bourns.

XIII.

AN ORANG HUNT IN BORNEO.

By Frank S. Bourns.

Mr. William T. Hornaday, in his interesting book of travels, "Two Years in the Jungle," gives the habitat of the orang-outang as Northern Sumatra and Borneo. As it is limited to a small area in the former island, he considers Borneo the true home of this great ape. Nor is it evenly distributed over Borneo. Mr. Hornaday gives its range as the great plain of the west and north; but it is also quite abundant in the northeast and east, the territory occupied by the British North Borneo company.

Fairly well defined areas of this vast region however seem to be avoided by the orang. For example, in Sarawak, where all of the orangs now in the possession of the Minnesota Academy of Natural Sciences were obtained, in the region between the Sarawak and the Sadeng rivers, very few if any orangs can be found. But in the adjacent territory between the Sadeng and the Batang Lupar rivers, they are fairly abundant, while still farther on to the northeast they again disappear or become very scarce, the reason given being that the natives of this region use them for food and thus keep down the number. This practice is not followed in the regions about the upper Sadeng, Simunjan, and Lingga rivers.

In the region between the Sadeng and the Batang Lupar rivers, the orang is probably more plentiful than in any other part of Sarawak. The country is for the most part a huge swamp for fifty miles back from the sea. A few ridges of high land run down from the mountains towards the coast, and at intervals of a few miles, isolated hills or groups of hills, rise from the swamp. The water varies in depth from a few inches to several feet, being greater of course during the rainy season. For several miles back the tide has a decided influence, backing the water up for several feet and causing a reverse current in all the rivers and streams. The whole region, both swamp and highands, is densely wooded.

This is where the orang makes his home. Home is hardly an accurate word to use, for the orang's home is wherever night happens to overtaken him. When darkness falls, the animal selects some small tree with a bushy top, where he soon builds his nest. This nest, or "lampin," as the Dyaks call it, is a platform of leaf-covered branches placed in a secure place in the tree. In making it, the animal reaches out in every direction and breaks off or bends over all of the branches it can grasp. These are arranged in a careless manner so as to form a rude but substantial platform or nest, the smaller leafy branches serving to make it quite comfortable. Here the orang-outang sleeps, flat on his back, one or both feet firmly grasping a limb of the tree, with perhaps one hand similarly employed. Mr. Hornaday is of the opinion that the same nest is occupied for several successive nights, but careful inquiries among the Dyaks lead me to believe that it is more probable it is used but once, the animal preferring to build a new nest, to returning, even for a short distance, to an old one. These deserted nests are very abundant in the jungle, especially along the edges of small streams. A wounded orang will often betake itself to some high tree and hastily built a nest as a protection against the bullets of its pursuers. If these happen to be Dyaks, with their old rusty flintlocks, such protection serves its purpose admirably, but of course it is worthless against 45-90 Winchesters.

Two or three methods may be followed in hunting the orang-outang. The best is by boat, using a small "dug-out," with two Dyaks to paddle. By following along the small streams and water ways cut through the swamps by the Dyaks, one can move very quietly and can cover a long distance in a day. The chances of success are good, as the orangs frequently resort to the edges of these small streams for the purpose of feeding on the tender shoots of the "bladdin," or screw pine. Another method is to hunt over the hills, or just along the edge of the swamp, while the third is to wade right into the swamp after the game. This method is not very satisfactory, and involves the hunter in exceedingly hard work. It is much more successfully done by the almost naked Dyaks, who have spent the most of their lives wading in these very swamps.

My first successful hunt after orangs was comparatively easy work. We had gone a full day's journey up the Simangang river, stopping over night at the last Dyak house. This happened to be situated within four or five miles of a "gunong," or hill, and the Dyaks thought that an orang, or mias as they called it, might be obtained there. So, accompanied by a locally celebrated Dyak hunter named Pasang, the Orang Kaya (head man of the village), and "Kadir," my Malay guide, we started early in the morning following what, by courtesy, the Dyaks called a road. This consisted of a row of poles from half an inch to two or three inches in diameter, placed end to end over the worst places in the swamp. One is supposed to walk these as a rope walker does a rope. This my barefooted companions did very successfully. I soon got so that I could balance myself fairly well, but about once in every hundred rods would slip and go in up to the hips. We finally reached the hill and then divided into two parties, Pasang going on one side of the hill, we on the other. Many nests were seen and any number of small monkeys, but no orangs. About noon however we heard a faint signal which the Orang Kaya said was from Pasang. Half an hour later we found him carefully following two mias, which he had met far down in the swamp, and which he had tried to kill with his old flintlock. In this he had failed, and as the orangs had quickly fled to the high trees, they were quite safe from the clumsy bullets of Pasang's old gun. A fine male orang in one of the highest trees was now pointed out to me. I had with me both a 38- and a 45-caliber rifle, and not wishing to injure the skeleton more than was necessary, I took the 38 and fired. The orang uttered a low growl and hastily made off through the treetops. This caused great excitement and fearing to lose him, I quickly took the 45 Winchester from one of the men, and as the orang was swinging himself along hand over hand, aimed at his huge hairy breast and fired. For a moment he hung there, and then came crashing down, a distance of 80 feet or more, falling with a loud thud, and with such force as to break several bones. The fall knocked out of him what little life he had, so we went up to him immediately. What a fine fellow! Not one of the very largest, but a well-grown orang weighing more than one hundred pounds, with hair several inches long hanging from his arms and shoulders.

We admired him for a moment then turned our attention to his mate which we soon found and brought down. Elated with our success we bound the animals up and started home, Pasang carrying the larger and the Orang Kaya the smaller of the two. The animals were both the "mias rombi" of the Dyaks. They recognize three distinct varieties, the "mias chappin" or largest, the "mias rombi" or medium and the "mias Kassa," or smallest variety. The "mias chappin" is always a huge beast with very long red hair on the breast, shoulders and arms, and is characterized by large cheek callosities. These give the face a peculiarly ugly and ferocious expression. The canine teeth are long, projecting far beyond the others, so that the expression of an enraged animal is extremely ferocious.

The female of this variety does not posses the cheek callosities, nor is she so large. The "mias rombi" is very similar to the "mias chappin" but lacks the cheek callosities. Usually too it is somewhat smaller and has shorter hair. The "mias Kassa" is quite small, almost a dwarf. These are the varieties recognized by the Dyaks. Among naturalists some difference of opinion has existed as to the number of species of the orang, and two have usually been recognized, "Simia satyrus" and "Simia wurmbii." Mr. Charles Hose, in his recent monograph on the "Mammals of Borneo," recognized but a single species. This is the opinion now held by many naturalists, the differences in size, length of hair, cheek callosities, etc., being partly sexual and partly accidental.

The day after the successful hunt, we continued on up the river almost to its source, as far as Gunong Bulan (moon hills). After four or five days of hard work we had captured but one orang, a thin sickly-looking female which the Dyaks insisted had malarial fever. They maintain that the orang is as much subject to fever as is man, that when afflicted the animal will lie in the nest for days, groaning loudly during this time, and that as a result of the fever, it becomes greatly emaciated. We had here a positive proof of one of these facts, for this animal looked as poor as did many a native whom I had seen, who had had malarial fever for some weeks. That the animal groans I afterwards had a chance personally to verify. In fact it seems perfectly rational that the orang can be afflicted with this disease, just as can any person who is so unfortunate as to live in the swamp, where the malarial plasmodium is ubiquitous.

On our way back we secured one more orang, and its capture shows well the pleasures of hunting in a Borneo swamp.

We were floating slowly down stream when we came upon a flock of "rasongs" or proboscis monkeys. As they are valuable animals it was desirable to secure some, so I ordered the men to follow into the swamp and get within range. After going fifty yards I got a long range shot at one big fellow, but hit him too low so that he was able to make off. The boat followed a short distance, but soon became fast in the roots and vines, and, as there was nothing else to do, we went over the side, at first going in up to the shoulders. Wading cautiously along, avoiding briars and thorns as much as possible, we followed the wounded animal, but each time we approached him he would make off before we could get a shot. Going in this way we were soon a quarter of a mile away from the boat. Just then while peering anxiously up into a tree over our heads, we sighted an orang carefully concealed in the top. He was so well hidden that it was impossible to tell where to aim, so I fired at a venture expecting to take him again when he disclosed himself. The bullet broke his leg, and as he hastily started to make off I took quick aim and pulled the trigger. Click! That empty click that makes a hunter's heart sink was the only response. The rifle was empty, not a cartridge in my pocket, the boat a quarter of a mile away and the orang slowly making off. I well knew that I could not find my way to that boat and back again, so told Pasang that I would follow the animal while he returned for cartridges. At first the animal got ahead of me, but after a while it stopped and rested in the crotch of a tall tree. I carefully concealed myself and keeping perfectly quiet awaited the return of my guide. The animal did not attempt to go farther until again disturbed by the noise made by the returning Dyak, when a bullet quickly brought him down. In time we got back to the boat with our prize, but I was sore for a week from the scratches and bumps I got while struggling through that bog.

A few days later found us up the Sibuyan river far beyond Dyak houses. As there was no high ground in the region we wished to work, we were compelled to build a rough shanty directly over the swamp. From this place as a center, aided by the good hunters, we worked the surrounding country with good success. Orangs, proboscis monkeys, black monkeys and other animals came in quite rapidly. But at the end of the week I was seized with a annoying combination of fever and articular rheumatism. For a couple of days I stayed in camp, but the third day, feeling no better, I decided to go out in the boat, believing that recovery would come as quickly while being paddled about over the swamp, as it would lying on a platform of poles three feet above it. We took one of the small branches of the river and paddled along until past noon, without seeing anything. Then the order to return was given and we started back. An hour later as I was lying flat on my back, wondering how much more quinine it would require to conquer that fever, and wishing for an ounce or two of salicylate of soda for the rheumatism, I was aroused by the man in the bow of the boat, who cautiously whispered, "Mias Tuan, mias bazar" (an orang, sir, a big orang). The boat was cautiously stopped as I arose to a sitting position and grasped my rifle. Sure enough, there fifty yards down the stream was a large animal working his way through a dense thicket of screw pines that was between the forest and the channel. He had sighted us and slowly, and apparently without fear, was making his way towards the jungle. He was partially concealed by the thicket, so we dropped down the stream so as to get on the other side of him before he could gain the large trees of the jungle proper. We came in sight of him again, just as he was getting into the branches of the first large tree. For a moment we stopped and gazed at each other. What a monster! A face over twelve inches wide, a huge chest and broad shoulders, and arms having a reach of over eight feet from tip to tip. He growled and showed his long canine teeth, just as I raised my Winchester and fired. Slowly one leg dropped, then the other, then one hand loosened its firm grasp of the limb above, and for a moment he hung there by one long hairy arm. Then the other hand slowly relaxed its firm hold and down he came with a great splash. A few minutes later and not without much trouble, we had in our boat one of the largest orang-outangs ever killed. He weighed 151 pounds and was a prize in every way.

Usually it is not very dangerous sport hunting the orang-outang, as the living animal almost never comes to the ground and is quite helpless when it does. It is perfectly at home in the treetops, swinging along from tree to tree with the greatest ease. One seldom meets with more than one at a time. Sometimes a pair of rather young ones may be found, or perhaps. an old female with a young one of two years and another in arms. My hunter Pasang said that he once met four feeding together, but they were all small. The old males always go alone, meeting occasionally, when a royal battle in the trees is apt to follow. The marks of these fierce conflicts can usually be found on an old male, a finger bitten off or a piece of the lip gone showing how savagely they fight.

Stories of orangs throwing cocoanuts at hunters are all travelers' tales. Their only foundation is in the fact that an old female with young, if attacked, will break off large branches from the tree, and drop them down at any one who happens to be underneath. This I have myself seen, and so active was the animal in her work, that it was dangerous to remain under the tree as branches as thick as one's wrist came crashing down at frequent intervals.

The most remarkable instance of sagacity, or, as it seemed to me, reason, that I ever saw exhibited by an orang, was by an old female carrying a young one of two or three months. The young is always carried astride the hip, the little one holding on to the long hair of its mother with both hands and feet. On the occasion referred to, we met an old female with young, and as we were desirous of securing the young one alive I aimed to inflict a fatal wound without injuring the little one. On being struck the mother loosed the hold of her feet and hung at full length by the arms. Seeing that she would fall in a few moments, I refrained from firing a second shot in spite of repeated requests from my guide Pasang, who seemed much concerned because I did not shoot again. Presently one arm dropped and I held myself in readiness to rush forward and secure the young one before it could drown. But just at that moment the mother, realizing that she herself must fall, reached up grasped the young one, tore it forcibly from her, and, after placing it carefully on the branch above, fell. It may have been instinct, but certainly nothing better could have been done under similar circumstances, by a human being.

A young one of six months, purchased of the Dyaks, though at first very savage, soon became a great pet with me. It was never so happy as when close by me, and if I would permit it, would sleep contentedly with its arms about me. The only time it ever attempted to bite was when it was being taken away to its box. Many a frolic we had and many a pleasant half hour I spent, while watching its quaint ways. On one occasion while riding in an uncovered boat, it began to rain. The little orang, which had been sitting by my side, seemingly lost in deep thought, quietly reached over and attempted to take from me the paper I was reading. This I resisted for a while, but as it persisted I let it have it to see what new whim it had in mind. The paper was carefully pulled over its head and arranged as a shelter, next followed my broad-brimmed sun hat which was lying near, and there sat the little fellow, quite happy in having a good protection against the rain. Many such acts of intelligence led me to become quite attached to my little pet, and it was a sad day indeed when he sickened and died.

Just a few words in regard to the size attained by the orang-outang. Mr. Hornaday in his book discusses the question at length, citing Mr. Alfred R. Wallace in his work on the "Malay Archipelago." Mr. Wallace places the maximum size of specimens seen by him, or by reliable authorities, at 4 ft. 2 in. Mr. Hornaday records no less than seven specimens collected by himself, that exceeded this height, the largest being 4 ft. 6 in. While at Saudakan for a few days, I was told by Mr. W. B. Pryer, a well-known resident of British North Borneo, of an orang that had been killed and measured, whose height was 4 ft. 10 in. As this information was perfectly reliable, I was prepared somewhat against surprise when I succeeded in getting three specimens over 4 ft. 6 in. in height. One of these was 4 ft. 6½ in., another 4 ft. 8½ in., and the third 4 ft. 10¾ in.

As I had Mr. Hornaday's book with me, and therefore his figures, I was particular to make all measurements in conformity with the rules he gives, repeating two or three times the principal measurements to avoid error. The measurements of the largest orang I secured in Borneo, as taken at the time, are:

Length, head to heel	**4 ft.**	**10¾ in.**
Spread to arms	**8 "**	**3½ "**
Length of arm	**3 "**	**7 "**
" " hand	**1 "**	**½ "**
" " foot	**1 "**	**2½ "**
Breadth of face	**1 ,'**	**1 "**

Circumference of neck	2 "	3¼ in.
" " chest	3 "	3¼ "
" " abdomen	3 "	1 "
" " arm	1 "	½ "
" " forearm	1 "	3 "
" " thigh	1 "	9½ "
" " leg (calf)	1 "	0 "

In regard to weight, Mr. Hornaday estimates the weight of the largest animal at 185 pounds. The actual weights of the largest two secured by me were 147 and 151 pounds, the tallest animal lacking four pounds of the weight of the next tallest. If Mr. Hornaday was correct in his estimate of the weight of his orangs, they were certainly in prime aldermanic condition.

CONTENTS

HALL, C. W. *Paper G.* The Structure, Lithology and Genesis of the Magnesian Series of the Northwestern States [Abstract] [illegible]

CHENEY, WILLIAM. *Paper H.* Meteorological Statistics [illegible]

WORCESTER, DEAN C. AND BOURNS, FRANK S. *Paper I.* Letters from the Menage Scientific Expedition to the Philippine Islands . . . . . [illegible]

BOURNS, FRANK S. An Orang Hunt in Borneo [illegible]

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OF THE

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Vol. IV No. 1

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221st Meeting, January 8, 1895.

ANNUAL MEETING.

Nine persons present, Vice President Sudduth presiding.

Secretary C. W. Hall reported $169 collected during the year, of which $129 was in dues of members.

The corresponding secretary reported accessions to the library for 1894, as follows:

United States publications	521
Foreign publications	523
Total	1,054

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Report of the Corresponding Secretary of publications received during the year 1894:

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The Secretary was directed to cast the ballot of the Academy for the following officers:

President,	H. L. Osborn.
Vice President,	W. X. Sudduth.
Recording Secretary,	C. W. Hall.
Treasurer,	E. C. Gale.
Corresponding Secretary,	C. P. Berkey.
Trustees for three years,	H. V. Winchell. Verdine Trusdell.

A paper on The Classification of the Sexual Affinities of Prunus americana, by C. W. H. Heideman of New Ulm, was presented.

[ABSTRACT]

The uncertainty of regular annual fruiting of plums in the Northwest, where only the native *Prunus americana* in its many varieties has been found sufficiently hardy to endure the climatic conditions, has long been a difficult problem in Horticulture. The author undertook to determine the causes underlying this recurring non-productiveness in certain trees.

An examination of plum flowers showed that the following types occurred:

Hermaphrodite—Stamens and pistil present and maturing at same time.

Proterogynous—Receptive period of stigma expiring before pollen matures.

Proterandrous—Pollen discharged before stigma becomes receptive.

Long-styled—Style nearly twice as long as stamens.

Short-styled—Stamens nearly twice as long as styles.

Gyndoioecious—Anthers aborted.

Andromonoecious—Pistils aborted.

Hermaphrodite flowers are the only ones capable of self pollination, all the other types requiring cross-pollination. Trees with hermaphrodite flowers are now rarely found in the wild state.

By his experiments the author found that certain crosses produced large, fine fruit while other crosses resulted in the production of inferior fruit, or even no fruit at all. Of all the crosses possible between plants bearing these different types of flowers he found that only the eight following combinations would yield a desirable fruit:

Hermaphrodite X Hermaphrodite.
Hermaphrodite X Proterandrous.
Hermaphrodite X Proterogynous.

Proterandrous X Proterogynous.
Short-styled X Long-styled.
Short-styled X Gynodioecious.
Long-styled X Gynodioecious.
Andromonoecious X Gynodioecious.

222d Meeting, February 5, 1895.

Fifteen persons present, Vice President Sudduth presiding.

A paper on Special Forms of Ossification, by Dean W. X. Sudduth, was read, illustrated from specially prepared lantern slides.

223d Meeting, March 6. 1895.

The Minnesota Academy having accepted an invitation from the St. Paul Academy of Science to unite with them in a joint meeting of the two Academies for the month of March, it convened with the St. Paul Academy in the rooms of the St. Paul Commercial Club, Germania Bank Building, St. Paul, by invitation of that body. About 35 persons present. Rev. C. E. Mitchell, President of the St. Paul Academy of Science, presided.

The following program was presented:

The Physical Features of the Lake of the Woods, by Professor MacMillan, State Botanist of Minnesota.

Psychic Effects of the Weather, by Edw. A. Beals, Observer U. S. Weather Bureau.

Geology and Flora of the Mountain Region of Northeastern Montana, by R. G. McGinnis, Secretary of the St. Paul Commercial Club.

At the close of the meeting Secretary Hall, on behalf of the Minnesota Academy of Natural Sciences, invited the St. Paul Academy of Science to join them in a meeting to be held in the public library, Minneapolis, on April 2nd. The invitation was very cordially accepted.

224th Meeting, April 2, 1895.

Twenty-one persons present; President Osborn presiding.

The St. Paul Academy of Science, as the guest of the Academy, was represented by several members. The museum was opened and lighted for the inspection of members of the Academy and visiting friends.

The following program was presented:

Some Queer Forms of Shell Fish, by President Osborn.

The Relation of Fatigue to Social, Moral and Educational Progress, by H. S. Baker:

[ABSTRACT.]

All movements of mind or muscle result in the destruction of some kind or kinds of tissue, and the products of metabolism are thrown into the blood. The prompt removal of this debris of brain or muscle, is necessary for the health and happiness of the individual and for the best work of mind and body, because it is decidedly toxic to all organs. The brain is the motive power, and all fatigue is brain fatigue. The cells of some center are exhausted by every muscular movement. The liberal use of proteids helps the system to rally after fatigue.

Since all fatigue is brain fatigue, we should remember that we cannot do both mental and muscular work well at the same time. The student should do as little physical work as possible, before he begins his daily tasks. Continued hard work of mind and body in the same day, brings in its train disease of the brain, heart, stomach. We do not feed a horse when he is very tired because the stomach will not digest the food.

Physiological Psychology of the Emotions: The emotions produce fatigue rapidly. Emotions which are evil and violent, as anger and covetousness, consume the brain cells most rapidly and throw into the blood compounds containing nitrogen, which are very poisonous. Each emotion throws into the blood a different substance, or ash, as it may be called. Those which are holy, as worship and the social feelings, throw into the circulation substances which are good tonics to the entire system. The child who is praised for good conduct, by that act, has his intellect improved. Both the scold and the scolded become more stupid by their feelings. Each emotion produces a different odor in the perspiration, which enables a dog to follow his master in a crowd. To be disagreeable to a person is to give him blood-poison. Use of the intellect is reasonably tonic.

The higher feelings, such as the religious and social, first feel the effect of fatigue. A tired man may lose interest in his Bible and be cross to his family, but still be able to think connectedly. A man may drive a sharp bargain long after he can appreciate a painting or do an unselfish act. The man, benevolent on Monday morning, may be miserly Saturday afternoon. Self control also disappears with the advent of fatigue and the tired woman cries for nothing, the brakes are off so to speak, and the feelings run riot.

Both teachers and children should sit whenever possible. The teacher who stands all day before her school, is cross and stupid in the

afternoon.

The brain cells are repaired during sleep. But it is important to note that in any one night there cannot be complete recuperation. Thirty-six hours are required for the cells to become normal after fatigue. That is, the physiological no less than the religious Sabbath extends from Saturday evening to Monday morning. Sabbath breakers are less moral, less intellectual than they would be if they observed the Sabbath. They shorten their lives by Sabbath desecration: while they live they crowd the offices of specialists in nervous diseases.

The following persons were elected to membership, subject to the rules of the Academy:—Rev. John Grueiner, St. Paul; Harlow Gale, and Geo. C. Christian, Minneapolis.

The secretary read an invitation from Josephine D. Peary, inviting the Minnesota Academy of Natural Sciences to send a naturalist on the Greenland Scientific Expedition of 1895, which expedition is being fitted out for the purpose of bringing home Mr. Peary and his assistants from northwestern Greenland where they are at present engaged in scientific observations, particularly in Meteorology. The secretary was directed to express the interest of the Academy in the enterprise and its regrets that circumstances would not permit participating in the expedition.

The secretary announced the mounting of the group of Orangs by the Ward Natural History Establishment in Rochester, N. Y., and that this group would soon be shipped to Minneapolis.

225th Meeting, May 7, 1895.

Fifteen persons present; President Osborn in the chair.

The St. Paul Academy of Science was again the guest of the Academy, pursuant to invitations extended.

The following program was presented:

An Observation of Ants, by O. W. Oestlund.

Remarks on Some Birds New to Minnesota, by Dr. T. S. Roberts.

An Amine compound of gold, by H. B. Hovland.

The Chemical characters of the Minnesota sandstones, by Chas P. Berkey.

A review of known facts of the Chemistry of local Sandstones.

226th Meeting, October 15, 1895.

Nine persons present; C. P. Berkey presiding pro tem.

L. E. Griffin was elected to membership.

Program:

A Review of the Springfield meeting of the American Association for the Advancement of Science, by Herbert W Smith.

The Suppression of Crime, by Dr. Albert Schneider (read by Secretary Hall).

Some Geological Features of the vicinity of Franconia, Minn., by Chas. P. Berkey.

[ABSTRACT.]

Attention was called to the physiographic features at Franconia, Minn. A gorge is cut in the sedimentary series to the depth of 150 to 200 feet below the adjacent upland plain and extends westward from the St. Croix river gorge proper about half a mile. It is the lower portion of a small creek which sinks into the sand some distance above the gorge and issues as springs within the gorge itelf. The gorge is considered entirely post-glacial and due to the work of the present stream supplemented by the powerful springs issuing at the lower horizons. The rock formation being composed of fine sand of the St. Croix series is readily disintegrated and easily transported by such agencies.

227th Meeting, January 7, 1896.

Afternoon session at 2 P. M., in the lecture room of Professor of Public Health, University of Minnesota, Engineering Building. Thirty persons present. Dr. Chas. N. Hewitt, Chairman of the Section of Sanitary Science, presided and gave an address on the qualities of good water supply for public use. The address was a resumé of the present methods of examining, in a sanitary way, a water supply. It was illustrated by a large number of cultures, by slides showing the more common mechanical impurities under the microscope, and a large number of slides to show the more common bacilli of diseases connected in a more or less direct way with drinking waters.

C. W. Hall enumerated the chief artesian basins of the northwestern states, particularly of the Dakotas, Minnesota, and Wisconsin. The conditions of successful supply were discussed, and the more pronounced chemical characters named particularly as they appear in the shallower wells receiving their water supply from the glacial drift.

The evening session was held in the directors' room of the Public Library.

Thirty-five persons present; Dr. C. N. Hewitt in the chair.

Public water supplies were described:

St. Paul, by City Engineer Rundlett.
Minneapolis, by City Engineer Cappelan.
Winona, by City Engineer Housten.
St. Cloud, by City Engineer White.
Stillwater, by Hon. E. W. Durant.

228th Meeting, January 15, 1896.

Adjourned annual meeting, Pillsbury Hall, University of Minnesota.

Five persons present; Dr. U. S. Grant president pro tem.

Reports of the secretaries were read, and ordered filed.

The following officers were elected:

President, - - - - - - - - Dr. Thomas S. Roberts.
Vice President, - - - - - - Dr. U. S. Grant.
Recording Secretary, - - - Alonzo D. Meeds.
Corresponding Secretary, - - Chas. P. Berkey.
Treasurer, - - - - - - - - Edward C. Gale.
Trustees for three years, - C. W. Hall.
Herbert W. Smith.

Report of the Corresponding Secretary for the year 1895:

[ABSTRACT.]

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Lausanne, Switzerland.—Société Vandoise des Sciences Naturelles: Bulletin, Vols. XXX, XXXI.

Lawrence, Kans.—Kansas State University: Quarterly, Vols. III, IV.

Le Havre, France.—Société de Géologique de Normandie: Bulletin, Vol. XV.

Liege, Belgium.—Société Géologique de Belgique: Annales, Vol. XXI.

Lincoln, Neb.—University of Nebraska: Studies, Vol. II: 1.

Liverpool, England.—Geological Society: Proceedings, Vol. VII: 2.

Lüneberg, Germany.—Naturwissenschaftlicher Verein: Jahresbericht, Vol. XIII.

Madison, Wis.—Academy of Sciences, Arts and Letters: Transactions, Vol. X.

Manchester, England.—Manchester Literary and Philosophical Society: Memoirs and Proceedings, Vols. VIII: 3; IX: 1, 2.

Mexico, Mexico.—Instituto Geologico Nacional: Bulletin, No. 10.

Milano, Italy.—Società Italiana di Scienze Naturali: Atti, Vol. XXXV.

Milwaukee, Wis.—Public Museum of Milwaukee: Annual Report, Vol. XII.

Minneapolis, Minn.—Geological and Natural History Survey: Annual Reports, Vols. XXII, XXIII; Final Reports, Vols. I, II, III: 1.

Montevideo, Uruguay.—Museo Nacional: Annales, Vol. II: 2, 3.

Montgomery, Ala.—Geological Survey of Alabama: The Coosa Coal Field; Maps.

Montreal, Canada.—Canadian Record of Science. Vol. VI: 1, 2; VII: 1-4.

Moskva, Russia.—Imp. Moscow Society of Naturalists: Bulletin, 1894, Nos. 2, 3.

Münster, Germany.—Provincial-Verein für Wissenschaft und Kunst: Jahresbericht, Vol. XXII.

Nantes, France.—Société Académique de la Loire-Inférieure: Annales, Vol. V.

Nashville, Tenn.—State Board of Health: Bulletin, Vols. X: 6-11; XI: 1-4.

New Haven, Conn.—Connecticut Academy of Arts and Sciences: Transactions, Vol. IX: 2.

New York, N. Y.—American Geographical Society: Bulletin, Vols. XXVI: 4; XXVII: 1-3.

New York, N. Y.—American Museum of Natural History: Annual Report, 1894; Bulletin, Vol. VI.

New York, N. Y.—Linnean Society: Abstracts of Proceedings, No. 7.

New York, N. Y.—Microscopical Society: Journal, Vols. X: IV; XI: 1, 2, 4.

New York, N. Y.—Torrey Botanical Club: Bulletin, Vol. XXII.

Nürnberg, Germany.—Naturhistorische Gesellschaft: Abhandlungen, Vol. x: 3.

Oberlin, Ohio.—Oberlin College: Library Bulletin, Nos. 1, 2; Wilson Bulletin, Vol. iii: 4.

Offenbach, Germany.—Verein für Naturkunde: Berichte, Vols. xxxiii-xxxvi.

Osnabrück, Germany.—Jahresbericht, 1893, 1894.

Padova, Italy.—Società Veneto-Trentina di Scienze Naturali: Atti, Vol. ii: 1; Bulleti, Vol. vi: 1.

Paris, France.—Museum d' Histoire Naturelle: Bulletin, 1905.

Penzance, England.—Royal Geological Society of Cornwall: Transactions, Vol. xi: 9.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, 1895.

Philadelphia, Pa.—Zoological Society of Philadelphia: Annual Report, Vol. xxiii.

Portland, Maine.—Portland Society of Natural History: Proceedings, Vol. ii: 3.

Port Louis, Mauritius.—Royal Alfred Observatory: Annual Report, 1893; Meteorological Observation, 1893.

Prag, Bohemia.—K. Böhmische Gesellschaft der Wissenschaften. Jahresbericht, 1894; Sitzungsberichte, 1894.

Providence, R. I.—Rhode Island Historical Society: Publications, Vols. ii: 4; iii: 1-3.

Reichenberg, Bohemia.—Verein der Naturfreunde: Mitteilungen, Vol. xxvi.

Riga, Russia.—Naturforscherverein: Korrespondenzblatt, Vol. xxxvii.

Rochester, N. Y.—Rochester Academy of Natural Sciences: Proceedings, Vol ii.

Sacramento, Cal.—California State Mining Bureau: Report, Vol. xii; Bulletin No. 6.

St. Gall, Switzerland.—Naturwissenschaftlicher Gesellschaft: Berichte, 1892, 1893.

St. John's, New Brunswick.—Natural History Society: Bulletin, No. 12.

Saint-lô, France.—Société d' Agriculture, d' Archeologie et d' Histoire Naturelle: Memoires et Docum, Vol. xii.

St. Louis, Mo.—Missouri Botanical Garden: Annual Report, Vol. vi.

St. Paul, Minn.—Minnesota Historical Society: Historical Collections, Vol. vi: 3; Biennial Report, 1895.

Sankt Peterburg, Russia.—Imp. Academy of Sciences: Bulletin, Vol. 1, 2; Memoirs, Vols. xxxix, 2; xli, 5, 8, 9; xlii, 2, 3, 5, 11, 12; N. S. Vol. i. 1, 4.

Sankt Peterburg, Russia.—Geological Committee: Bulletin, Vols. xii: 8, 9; xiii: 1-3; Memoires, Vols. viii: 2, 3; ix: 3.

Semur-en-Auxois, France.—Société des Sciences Historiques et Naturelles: Bulletin, No. 8.

Sydney, New South Wales.—Australian Museum: Records, Vol. ii: 6.

Sydney, New South Wales.—Geological Survey of New South Wales: Annual Report, 1894, Memoirs, Nos. 8, 9.

Sydney, New South Wales.—Royal Society of New South Wales: Journal and Proceedings, Vol. XXVIII.

Stavanger, Norway.—Stavanger Museum: Aarsberetning, 1893.

Stockholm, Sweden.—Geologiska Byron, Afhandlinger, Ser. C. Nos. 136-159.

Stockholm, Sweden.—Kongl. Svenska Vetenskaps-Akadamein: Bihang, Vol. XIX. Ofversigt, 1893, 1894.

Tokio, Japan.—Deutsche Gesellschaft für Natur und Völkerkunde: Mitteilungen, Vol. VI: 55, 56. Suppl. II.

Torino, Italy.—R. Museo Zoologico di Torino: Bulletin, Vol. x; 193-209.

Toulouse, France.—Académie des Sciences, Inscriptions et Belles-Lettres: Memoires, Vol. VI.

Washington. D. C.—United States Geological Survey: Annual Report, Vol. XIV; Bulletin, Vols. CXVIII-CXXII; Monographs, Vols. XII, XXIV.

Washington. D. C.—Patent Office: Official Gazette, Vols. LXIX: 12, 13; LXX; LXXI; LXXII; LXXIII: 1-12.

Washington. D. C.—Weather Bureau: Monthly Weather Review, 1892, 1893. 1894; Report, 1891, 1892, 1893; Bulletin, B. and C.

Zurich, Switzerland.—Naturforschende Gesellschaft: Vierteljahrschrift, Vols. XXXIX: 3, 4; XL: 1, 2.

Zurich, Switzerland.—Physikalischen Gesellschaft: Jahresbericht, 1893-1894.

National. United States.—American Association for the Advancement of Sciences, Vol. XLIII.

229th Meeting, March 3, 1896.

Four members present.

Program:

Paper on An Exploring Expedition in the Rockies of Northwestern Montana, by Professor L. W. Chaney of Carlton College, Northfield.

Short talk on Geological Excursions and Field Work in a German University, by F. W. Sardeson.

Some notes on analyses of clays were given by C. P. Berkey.

230th Meeting, December 8, 1896.

Fifteen persons present; President Dr. Thos. S. Roberts presiding.

The secretary was directed to send a vote of thanks to Dr. Dunsmoor for the present of the vertebra of a whale.

Professor Hall spoke of the death of Verdine Truesdell, a member of the Board of Trustees; a committee was appointed to draw up resolutions.

Prof. Winchell brought up the matter of establishing a state academy of natural sciences to receive some support from the state, and suggested the advisability of making the Minnesota Academy the state academy.

Mr. H. C. Hanke suggested that action should be taken by the Academy recommending to the Legislature some change in the game laws in order more fully to protect the game of the state. Mr. Hanke and the President were appointed a committee to investigate and report to the Academy.

Program:

Some Features in the Geology of Northeastern Minnesota, by Prof. N. H. Winchell.

[ABSTRACT.]

The features noted in detail related to: (1) *The nature of the transition from the crystalline schists to the Laurentian.* After the description of the field facts to be observed on the dull point in Vermilion lake which embraces the corners of sections 13, 14, 21 and 32, T 63-17, the author concluded that the transition from the crystalline schists to the igneous and granite was of the nature of a gradual conformable change accompanied by silicification, and by a change of the schists themselves to gneisses, in the first place, and finally to granite by hydro-thermal fusion, and that the granitic rock penetrated the schists by generation in them of granitic minerals, in the first place, and later, or nearer the seat of greater heat, by actual intrusion in a molten form. (2) The *nature of the relations of the Stuntz conglomerate of Vermilion lake.* The author stated that evidence was discovered in a late excursion to Vermilion lake to demonstrate that this rock is a true conglomerate and not a breccia. It graduates into a quartzite and into a graywacke and the graywacke into argilliceous slate, these latter, constituting with the conglomerate, an upper formation non-conformable on the Vermilion iron-bearing formation. (3) *The nature and the position of the conglomerate in the Puckwunge valley.* This is composed of quartz pebbles, essentially, which are referable to the Animikie, some of them being composed of cryptocrystalline silica like that in the rock taconyte, and as a formation it lies above a peculiar greenish graywacke (named the Puckwunge slate) and is overlain by trap and amygdaloidal rock resembling the Keweenawan traps. It wah found that this conglomerate constitutes the base of an important part of the Keweenawan, or separates the Keweenawan into two great members.

(This paper is printed in full in the American Geologist for July, 1897.)

Notes on Saganaga Granite, by U. S. Grant.

The August meeting of the American Association for the Advancement of Science, by Prof. C. W. Hall.

231st Meeting, January 5, 1897.

ANNUAL MEETING.

Nine persons present; Vice President Grant in the chair.

Claude Hafer was elected a member of the Academy.

The Secretary reported $64 collected.

The Corresponding Secretary reported the library accessions as 272 domestic and 399 foreign, total of 672, as follows:

Agram, Hungary.—Jugoslavenska Akademija: Ljetopis, Vol. x. Rad, Vol. xx.

Agricultural College, Mich.—Michigan Agricultural College and Exp. Station. Bulletin, Nos. 129-134.

Albany, N. Y.—State Library: Annual Report, 1894; Bulletin, No. 6.
State Museum: Annual Report, 1894; Entomologists' Report, Vol. x; Bulletin, Vol. III, Nos. 14-15.
University of N. Y.: Regents' Report, 1895.

Amiens, France.—Société Linnéenne du Nord: Bulletin, Vol. XII, No. 271; XIII: 272-282.

Baltimore, Md.—Johns Hopkins University: Circular, Nos. 123-127.

Berlin, Germany.—R. Friedländer und Sohn: Naturæ novitates, 1895: 19-24; 1896: 1-19.

Béziers, France.—Société d' Etude des Sciences Naturelles: Bulletin, Vols. XVII, XVIII.

Bologna, Italy.—Accademia delle Scienze dell' Instituto di Bologna. Memorie, Vol. IV.

Bombay, India.—Asiatic Society: Journal, Vol. XIX, No. 52

Bône, Algeria.—Académie d' Hippone: Comptes Rendus, 1895; Bulletin, No. 27.

Boston, Mass.—American Academy of Arts and Sciences: Proceedings, Vols. XXX, XXXI.

Boston, Mass.—Boston Society of Natural History: Proceedings, Vol. XXVII.

Boston, Mass.—Horticultural Society: Transactions, 1895.

Bremen, Germany.—Naturwissenschaftlicher Verein: Abhandlungen, Vol. XIII, No. 3.

Brisbane, Queensland.—Geological Survey of Queensland: Annual Progress, 1895; Bulletin, Nos. 3, 4; Water Supply, 1890, 1891, 1894.

Brisbane, Queensland.—Royal Society of Queensland: Proceedings, Vol. xi.

Brünn, Austria.—Naturforschender Verein: Bericht, 1893; Verhandlungen, 1895.

Bruxelles, Belgium.—Société Belge de Microscopie: Annales, Vols. xix: 2, 20; Bulletin, Vol. xxii.

Bruxelles, Belgium.—Société Entomologique de Belgique: Annales, Vol. xxxix.

Bruxelles, Belgium.—Société Royale de Botanique de Belgique: Bulletin, Vol. xxxiv.

Buenos Aires, Argentine.—Instituto Geographico Argentino: Bulletin, Vols. xvi: 5-12; xvii: 1-12.

Buenos Aires, Argentine.—Museo Nacional: Annales, Vol. iv.

Buenos Aires, Argentine.—Sociedad Cientifica Argentina: Annales, Vols. xl: 5-6; xli: 1-6.

Buffalo, N. Y.—Buffalo Historical Society: Annual Report, 1895.

Cairo, Egypt.—Institut Egyptien: Bulletin, Vol. v: 8, 9.

Calcutta, India.—Geological Survey of India. Memoirs, Vols. xiii: 2; xv: 2; xxvii: 1; Records, Vol. xxix: 2, 3.

Cambridge, Mass.—Harvard College Observatory: Annals, Vol. xxxiv: 1; Annual Report, 1895.

Cambridge, Mass.—Museum of Comparative Zoology: Annual Report, 1894-1895; Bulletin, Vols. xxix, xxx.

Cape Town, Africa.—South African Philosophical Society: Transactions, Vol. viii: 2.

Cardiff, England.—Naturalists' Society: Report and Transactions, Vol. xxviii.

Catonia, Italy.—Accademia Giœnia di Scienze Naturali: Bulletin, Nos. 41-47.

Chapel Hill, N. C.—Elisha Mitchell Scientific Society: Journal, Vol. xii.

Cherbourg, France.—Société Nationale des Sciences Naturales: Memoirs, Vol. xxix.

Chicago, Ill.—Chicago Academy of Sciences: Annual Report, Vol. xxxviii.

Chicago, Ill.—Field Columbian Museum: Publications, Nos. 7-11.

Chicago, Ill.—Journal of Geology: Vol. iv, 1896.

Christiania, Norway.—Videnskabs Selskab: Förhandlingar, 1894. Oversigt, 1894.

Chur, Switzerland.—Naturforschende Gesellschaft Graubündens. Jahresbericht, Vols. xxxix, xl.

Cincinnati, Ohio.—Cincinnati Society of Natural History: Journal, Vols. xviii: 3, 4; xix: 1.

Colorado Springs, Col.—Colorado College. Studies, Vol. vi.

Denver, Col.—Colorado Scientific Society: Uranite in Colorado; Pearcite; San Miguil Formation; Concretions, etc.

Ekaterinburg, Russia.—Société Ouralienne des Amis des Sciences: Bulletin, Vols. xiv: 1-4; xv: 1, 2.

Emden, Germany.—Naturforschende Gesellschaft: Jahresbericht, Vols. LXXIX, LXXX.

Firenze, Italy.—Bibliotica Nazionale Centrale: Bulletin, Nos. 239-274.

Frankfurt a d Oder, Germany.—Naturwissenschaftlicher Verein: Helios, Vol. XIII: 8-12: Societatum Litterae, Vol. X: 5-6.

Geneve, Switzerland.—Société de Geographie: Le Globe, Vol XXXV.

Georgetown, British Guiana.—Royal Agricultural and Commercial Society: Journal, Vol.

Glasgow, Scotland.—Natural History Society of Glasgow: Proceedings and Transactions, Vol. IV, Nos. 2, 3.

Görlitz, Germany.—Naturforschende Gesellschaft: Abhandlungen, Vol. XXI.

Graz, Austria.—Naturwissenschaftlicher Verein: Mitteilungen, Vol. XXXII.

Greifswald, Germany.—Naturwissenschaftlicher Verein: Mitteilungen, Vol. XXVII.

Guströw, Germany.—Verein der Freunde der Naturgeschichte: Archiv, Vol. XLIX.

Halifax, Nova Scotia.—Nova Scotia Institute of Science: Proceedings and Transactions, Vols. VIII; IX: 1.

Halle a d Saale, Germany.—Kais. Leopold. Carol. Akademie. Leopoldiana, 1895.

Hamburg, Germany.—Verein für Naturwissenschaftlicher Unterhaltung: Verhandlungen, Vol. IX.

Hamilton, Canada.—Hamilton Association: Journal and Proceedings, Vol. XI.

Harlem, Netherlands.—Musee Teyler: Archives, Vol. V: 1, 2.

Hermanstadt, Austria.—Siebenbürgischer Verein für Naturwissenschaften: Verhandlungen, Vol. XLIV.

Iowa City, Iowa.—Iowa Historical Society: Historical Record, Vol. XII.

Jefferson City, Mo.—Geological Survey of Missouri: Report, Vols. VIII, IX.

Kief, Russia.—Kief Society of Naturalists: Memoires, Vol. XIV.

Kiel, Germany.—Naturwissenschaftlicher Verein: Schriften, Vol. X: 2.

Krakowie, Austria.—Akademie der Wissenschaften: Rosprawy, Vols. VII, IX.

Landshut, Germany.—Botanischer Verein: Bericht, Vol. XIV.

Lansing, Mich.—State Agricultural College: Bulletin Exp. Station, Nos. 131-134.

Lawrence, Kans.—Kansas State University: Quarterly, Vol. V.

Le Havre, France.—Société de Géologique de Normandie: Bulletin, Vols. XVI, XVII.

Liverpool, England.—Geological Society: Proceedings, Vol. VII: 3.

Lyon, France.—Société Linnéenne de Lyon: Annales, 1894.

Manchester, England.—Manchester Literary and Philosophical Society: Memoirs and Proceedings, Vols. IX: 3-6; X: 1-3.

Melbourne, Victoria.—Public Library, Museum and National Gallery: Report of Trustees 1893-1894; 1894-1895.

Melbourne, Victoria.—Royal Geographical Society of Australasia: Transactions, Vol. XII, 1896.

Mexico, Mexico.—Instituto Geologico Nacional: Bulletin, No. 11.

Milano, Italy.—Società Italiana di Scienze Naturali: Atti, Vol. XXXVI: 3, 4.

Montevideo, Uruguay.—Museo Nacional: Annales, Vol. II: 4, 5.

Montgomery, Ala.—Geological Survey of Alabama: Bulletin, No. 5.

Moskva, Russia.—Imp. Moscow Society of Naturalists: Bulletin, 1894; 4; 1895.

Münster, Germany.—Provincial-Verein für Wissenschaft und Kunst: Jahresbericht, Vol. XXIII.

Nantes, France.—Société Académique de la Loire-Inferieure: Annales, Vol. VI.

Nashville, Tenn.—State Board of Health: Bulletin, Vols. XI: 5-12; XII: 1-4.

New York, N. Y.—American Geographical Society: Bulletin, Vols. XXVII: 4; XXVIII: 1-3.

New York, N. Y.—American Museum of Natural History: Annual Report, 1895; Bulletin, Vols. VII, VIII.

New York, N. Y.—New York Microscopical Society: Journal, Vol. XII: 1-3.

New York, N. Y.—Torry Botanical Club: Bulletin, Vols. XXIII, XXIV.

Nürnberg, Germany.—Naturhistorische Gesellschaft: Abhandlungen, Vol. X: 4.

Oberlin, Ohio.—Oberlin College: Bulletin, Vol. III: 7, 8.

Ottawa, Canada.—Geological and Natural History Survey of Canada: Annual Report, Vol. VII; Catalogue of Collection of Minerals.

Padova, Italy.—Società Veneto-Trentina di Scienze Naturali: Atti, Vol. II: 2; Bulletin, Vol. VI: 2.

Paris, France.—Museum d' Histoire Naturelle: Bulletin, 1896.

Penzance, England.—Royal Geological Society of Cornwall: Annual Report, 1896.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, 1896.

Pisa, Italy.—Società Toscana di Scienze Naturali: Atti, Vols. IX, X.

Port Louis, Mauritius.—Royal Alfred Observatory: Annual Report, 1894; Meteorological Observations, 1894.

Providence, R. I.—Rhode Island Historical Society: Publications, Vols. III: 4; IV: 1.

Regensburg, Germany.—Naturwissenschaftlicher Verein: Berichte, Vol. V.

Riga, Russia.—Naturforscherverein: Korrespondenzblatt, Vol. XXXVIII.

Rio De Janeiro, Brazil.—Instituto Historico, Geographico y Ethnographico: Revista, Vols. LVI, LVII, LVIII.

Rovereto, Austria.—Imp. R. Accademia degli Agiati in Rovereto: Atti, Vol. II: 3.

St. Gall, Switzerland.—Naturwissenschaftlicher Gesellschaft: Bericht, 1893-'94.

St. John's, New Brunswick.—Natural History Society: Bulletin, No. 13.

Saint-lo, France.—Société d' Agriculture, et d' Histoire Naturellede la Manche: Memoires et Docum. Vol. XIII.

St. Louis, Mo.—St. Louis Academy of Sciences: Transactions, Vol. VII: 1-9.

Sankt-Peterburg, Russia.—Imp. Academy of Sciences: Bulletin, Vol. III; Memoirs, Vols. II: 1, 2; III: 2, 6, 8; IV: 1, 2, 4.

Sankt-Peterburg, Russia.—Geological Committee: Bulletin, Vols. XIII: 4-9; XIV: 1-9; XV: 1, 2. Memoirs, Vols. IX: X: 3, 4; XI: 2; XIII: 2; XIV: 1, 3.

San Francisco, Cal.—California Academy of Sciences: Proceedings, Vol. V: 1, 2.

Santiago, Chile.—Société Scientifique du Chile: Actes, Vols. II: 5; VI: 1.

Sydney, New South Wales.—Australian Museum: Report of Trustees, 1895.

Sydney, New South Wales.—Geological Survey of New South Wales: Annual Report, 1895; Records, Vol. IV: 3, 4.

Sydney, New South Wales.—Royal Society of New South Wales: Journal and Proceedings, Vol. XXIX.

Stavanger, Norway.—Stavanger Museum: Aarsberetning, 1894, 1895.

Stockholm, Sweden.—Kongl: Svenska Vetenskaps-Akademien: Bihang, Vol. XX; Oefversigt, 1895.

Thorn, Germany.—Copernicus Verein für Wissenschaft und Kunst: Jahresbericht, Vols. XXXVI-XLII.

Tokio, Japan.—Deutsche Gesellschaft für Natur und Völkerkunde: Mitteilungen, Vol. VI, No. 57; Suppl. 3.

Torino, Italy.—R. Museo Zoologico di Torino: Bulletin, Vol. X: 211-221.

Toronto, Canada.—Canadian Institut: Transactions, Vol. IV: 2.

Toulouse, France.—Académie des Sciences de Toulouse: Memoires, Vol. VII.

Toulouse, France.—Société Francaise de Botanique: Revue, Vol. XII.

Upsala, Sweden.—Geological Institute University of Upsala: Bulletin, Vols. I, II.

Urbana, Ill.—Illinois State Laboratory of Natural History: Bulletin, Vol. III: pp. 483-501; Index; IV: p. 149-398.

Washington, D. C.—United States Geological Survey: Bulletin, Nos. 123-126, 128, 129, 131-134.

Washington, D. C.—National Museum: Bulletin, Nos. 39, I. J. K, H; 48. Proceedings, Vols. XVII, XVIII. Oceanic Ichthyology.

Washington, D. C.—Patent Office: Official Gazette, Vols. LXXIII: 13, 14; 74-78.

Washington, D. C.—Smithsonian Institution: Annual Report, 1893.

Washington, D. C.—Weather Bureau: Monthly Weather Review, 1895-1896.

Wiesbaden, Germany.—Naturhistorische Verein: Jahrbuch, Vols. XLVIII, XLIX.

Winnipeg, Manitoba.—Manitoba Historical and Scientific Society: Annual Report, 1894, 1895; Transactions, No. 48.

Zurich, Switzerland.—Naturforschende Gesellschaft: Vierteljahrschrift, Vols. XL: 3, 4; XLI: 1, 2.

Zurich, Switzerland.—Physikalischen Gesellschaft: Jahresbericht, 1895-1896.

Zwickau, Germany.—Verein für Naturkunde: Jahresbericht, 1894.

American Association for the Advancement of Science, Proceedings, Vol. XIV.

Australian Association for the Advancement of Science, Report, Vol. VI.

Election of officers resulted as follows:

President, - - - - - - - - Professor N. H. Winchell
Vice President, - - - - - - U. S. Grant.
Recording Secretary, - - - A. D. Meeds.
Corresponding Secretary, - - C. P. Berkey.
Treasurer, - - - - - - - Edw. C. Gale.
Trustees for three years, - T. B. Walker.
Dr. T. S. Roberts.
Trustee for unfinished term, of V. Truesdell, - - - Edward C. Gale.

The following resolution was adopted:

Whereas, The Minnesota Academy of Natural Sciences in the death of Verdine Truesdell has lost one of its most steadfast and earnest members, helpful in every place he was called upon to fill, and honored by every one,

Resolved: That the Academy do hereby express its sincere sorrow at the loss of a most respected member, that a copy of this memorandum be sent to the family of the deceased, and that a minute be spread upon the records of the Academy.

C. W. Hall,
U. S. Grant,
A. D. Meeds,
Committee.

The matter of a state academy, or state aid for the Academy, was introduced, and the following committee was appointed: Prof. N. H. Winchell, T. B. Walker, Dr. T. S. Roberts, and H. W. Smith.

Professor Hall announced that at the next annual meeting the Academy will have been in existence a quarter of a century; it was carried that a committee should be appointed for the proper celebration of the anniversary.

232d Meeting, February 2, 1897.

Eleven persons present; President Winchell in the chair.

Hon. Frank Ives of Crookston was elected to membership.

The committee on a state academy reported some progress, and, as it needed some legal advice, E. C. Gale was added to the committee.

Program:

Revision of Moraines North of Lake Superior, by A. H. Elftman.

Glacial Lakes of St. Louis and Nemadji, by Prof. N. H. Winchell.

[ABSTRACT.]

At the extreme western end of Lake Superior are beaches showing that that lake has been at higher levels and that it left distinct traces of itself. The first lake formed by the damming of the St. Louis river by the ice of the Lake Superior glacial lobe was a small lake wholly confined within Carlton county, about 523 feet higher than the present level of Lake Superior. It had its outlet to the southward, uniting with the waters of the St. Croix and thence reached the Mississippi river. Lake Nemadji was due to the same agent and was the first lake water, the residum of which remains to the present as a constituent part of the area of Lake Superior. This lake covered, in general, the valley of the Nemadji river and its level was 468 feet above the present level of Lake Superior. Its outlet was in secs. 16 and 17, T. 46, R. 18.

These glacial lakes are describel in Vol. 4 of the Final Report of the Geological Survey of Minnesota, pp. 18-21.

The eastern limit of Glacial Lake Agassiz, by U. S. Grant.

[ABSTRACT.]

The waters of Lake Agassiz are thought to have extended eastward so as to include the area now occupied by Rainy Lake. From the fact that the lacustrine deposits of the former lake extend eastward practically only to the western edge of the latter lake, it seems probable that the evtreme altitude of Lake Agassiz was in this area but a few feet

above the present level of Rainy Lake, or that such an extreme altitude was of short duration. The shores of Rainy Lake are generally rocky, and over much of them there are practically no deposits of unconsolidated materials, the bed rock coming to the surface wherever the thin forest soil is pushed aside. At the western end of the lake this rocky surface suddenly gives way to a plain of clays, through which the bed rock rarely emerges. These clays are regarded in the main as deposits made in the waters of Lake Agassiz. The change from the rocky country on the east to this clay plain on the west is abrupt and very striking, and is intensified by asudden change in the flora; the lake shores have a forest largely of evergreen and boreal in aspect, while to the west of the lake a forest largely deciduous and of less boreal aspect appears.

233d Meeting, February 9, 1897.

Six persons present; President Winchell in the chair.

Special meeting called to hear the report of the committee on a state charter. After two meetings of the committee and consultation with Judge Hicks of the Hennepin delegation it was found that the charter desired was special legislation and therefore unconstitutional. To get a state charter it would be necessary to transfer all the property of the Academy to the state, as well as to give complete control of its affairs to state officers. The committee was continued and instructed to report again.

A. D. Roe was elected to membership.

It was ordered that $10 be expended for the purpose of preserving some of the specimens, purchase of material, etc.; and that L. E. Griffin's offer to do certain necessary work in lieu of his current dues be accepted.

Communications from E. L. Brown of Warren, touching a collection of birds and animals, and Mr. Worcester, asking for the loan of several specimens of the Philippine Island collection. The latter communication was referred to the Trustees.

234th Meeting, March 2, 1897.

Eight persons present; President Winchell in the chair.

The president reported for the charter committee that it had drawn up a new charter and had submitted it to Capt. Cross, who had declared it unconstitutional. The committee was continued.

Program:

Some Reported Gold Discoveries in the Northwestern States, by C. W. Hall..

Dr. U. S. Grant gave an account of the Rainy Lake gold region.

[ABSTRACT.]

Rainy Lake lies in an area of crystalline and highly folded rocks, which have been separated by Lawson into two series called Coutchiching and Keewatin. The former series consists mainly of mica-schists, while the latter consists of various slates and schists, among which greenstone schists and also massive greenstones are common. Traversing these rocks are quartz veins, some of which carry values in gold. The best veins lie either in the green schists or in other rocks of igneous origin, and the most promising prospects occur on the Canadian shores of the lake. (An account of this district has been published in the 23d Annual Report of the Geological and Natural History Survey of Minnesota, pp. 36-105, 1895, under the title "Preliminary Report on the Rainy Lake Gold Region," by H. V. Winchell and U. S Grant; also in Vol. 4 of the Final Report of the same survey, pp. 192-211, 1899.)

C. P. Berkey read a paper on An Improved Method for Quantitative Determination of Antimony, Zinc, Iron, Copper, and Lead in an impure Galena ore.

[ABSTRACT.]

The investigation and experiences resulting in these notes arose over a particular ore brought from the Kootenai country in British Columbia. Mr. Stevenson, a special student in the laboratories of the University of Minnesota, was equally interested in them.

The ore contains from 50% to 80% metallic lead which is in the form of the natural sulphate, PbS. The impurities which make up the rest of the required amount are antimony, zinc, iron, copper and siliceous gangue matter. Antimony is the most common impurity and occurs in largest amount next to lead. It is in the form of sulphide $Sb_2 S_3$. It was chiefly in the effort to determine this constituent that the first and greatest difficulty arose. The natural association seemed to have so thoroughly satisfied the chemical affinities that the usual methods of solution were ineffectual, and separation did not occur where it was calculated to. Iron and zinc occur in similar amount, both in sulphate form, FeS_2 and ZnS. Copper is not always present in quantity of importance, but occasionally in considerable amount with iron as chalcopyrite, $CuFeS_2$. The siliceous gangue is present in amount varying from 0 to 15% according to quality of the ore.

The first difficulty was in securing complete solubility of the ore, the next was the almost constant failure to obtain precipitates of any

of the compounds entirely free from either lead or antimony or both.

No less than twenty different variations of process recommended by authors of texts and practical chemists were tried with no complete success. At last the following plan was devised which at least for the ore in question works with entire satisfaction.

PROCESS.

1. Digest one gram of ore in strong hydrochloric acid containing a little nitric acid, for half an hour. Then if necessary add more hydrochloric acid and about 5cc of nitric to complete the solution. Heat a few minutes and dilute. Filter and weigh residue as insoluble siliceous gangue.

2. Boil the filtrate and add enough dilute sulphuric acid to precipitate all of the lead in the form of $PbSO_4$. Add alcohol and allow to stand several hours, or better, evaporate till white fumes appear. Dilute cautiously, filter and weigh.

3. To the filtrate from the precipitation in (2) add ammonium chloride and ammonia in considerable excess. The precipitate contains the iron in the form of $Fe_2 O_6 H_6$ which is filtered and ignited and weighed as $Fe_2 O_3$.

4. Pass $H_2 S$ gas through the filtrate from (3). A grayish white precipitate of zinc, ZnS, and of copper, CuS, are formed. Filter. The filtrate contains antimony still in solution, the two mixed precipitates must be treated for separation.

5. To the filtrate from (4) add hydrochloric acid to acid reaction and H2S gas. Antimony sulphide $Sb_2 S_3$ forms. Filter and follow the usual method of handling this precipitate.

6. Dissolve the precipitate from (4) in hydrochloric acid. To this add H_2S gas which will precipitate copper as CuS. Filter and ignite weighing as either $Cu_2 S$ or $Cu_2 O$. (The amount of copper is the same in each.)

7. To the filtrate from (6) add ammonia to strong reaction and pass $H_2 S$ gas through. Zinc is precipitated, ZnS. Weigh as Zn O.

Analysis of the ore made after this scheme separated easily and completely, and the results checked within the usual limits of error.

The list of delinquent dues was referred to Professor Hall and Secretary Meeds.

Hon. Frank Ives of Crookston, Minn. was elected delegate of the Academy to the International Congress of Geologists to be held at St. Petersburg during the coming summer.

235th Meeting, April 5, 1897.

Twenty-one persons present.

President Winchell in the chair.

Program:

An Account of a Glacier in the Montana Rockies, by Prof. L. W. Chaney, Jr.

The Stillwater Oolite and its Fossils, by A. D. Roe.

Sketch of the Life of Verdine Truesdell.

A case was asked for the display of a collection of Indian curiosities which were offered on loan by Mrs. Leach; referred to a committee of Dr. Roberts and the secretary.

236th Meeting, May 4, 1897.

Six persons present.

President Winchell in the chair.

Amendment to the By-Laws, notice of which was given at the last meeting, was adopted by which the dues of resident members was reduced from $5.00 to $3.00 per annum.

Moved and carried that all delinquent dues up to January 1, 1897, be remitted.

Professor F. P. Leavenworth was elected to membership.

Dr. U. S. Grant read a paper on Minnesota Lakes having more than one Outlet.

[ABSTRACT.]

Among the numerous lakes in the northeastern portion of the state are several which have two outlets each. Such are: Brulé Lake in Cook County; a small lake on the International boundary between Gunflint and Saganaga lakes in Cook County; three lakes along the Kawishiwi river in Lake County; Iron Lake, Lac la Croix, and Namekan lake on the International boundary on the northern edge of St. Louis County. The origin of two outlets in a lake of this class is due to inequalities of drift deposition such that a basin is left with two depressions of about equal altitude in its rim. In case of at least one of the larger lakes,—Brulé lake,—it is possible that the western outlet is of quite recent date and is due to the westward canting of the basin by the general tilting which has been taking place in the Great Lake region since near the end of Glacial time.

(This paper has been published in the American Geologist, Vol. 19, pp. 407-411, June, 1897, under the title "Lakes With Two Outlets in Northeastern Minnesota.")

237th Meeting, October 5, 1897.

Fourteen persons present.

President Winchell in the chair.

Acceptance and thanks were ordered for the gifts to the Academy of a fine Tarpon from Florida by M. B. Koon and R. R. Rand, and of a valuable collection from Mr. J. C. Eliel.

Mr. E. C. Gale moved that a committee of five, of which the President shall be chairman, be appointed to provide a fitting reception and entertainment for Dr. Nansen upon the approaching occasion of his visit to Minneapolis.

An account was given by Dr. H. T. Eddy of the meetings of the American Association for the Advancement of Science at Detroit and the British Association for the Advancement of Science at Toronto.

238th Meeting, November 2, 1897.

Six persons present.

President Winchell in the chair.

Dr. H. T. Eddy was elected to membership.

A paper on the Driftless Area was read by Dr. F. W. Sardeson; discussion by Warren Upham.

(See Glacial Deposits in the Driftless Area, American Geologist, Vol. xx, 1897, pp. 392-403).

The following committee was announced for the proper celebration of the twenty-fifth anniversary of the founding of the Academy: President N. H. Winchell, Warren Upham, H. V. Winchell, E. C. Gale, and A. D. Roe.

A public reception was held November 19, 1897, in honor of Dr. Nansen, the Arctic explorer, in the Public Library, to which the Academy's committee, President Winchell, E. C. Gale, F. W. Sardeson, H. V. Winchell, and H. T. Eddy, had sent invitations. One hundred persons were present.

239th Meeting, December 7, 1897.

Eleven persons present.

President Winchell in the chair.

C. M. Dorsett and Wm. Twing were elected to membership.

It was moved and carried that the committee for securing state aid for the Academy be instructed to formulate a plan fulfilling statutory requirements for bringing the Academy under control of the Board of Regents of the University, present the same to the Regents, and report back to the Academy. Plans for the 25th anniversary were discussed.

240th Meeting, January 4, 1898.

ANNUAL MEETING.

Eight persons present.

President Winchell in the chair.

Reports of the Nansen reception and twenty-fifth anniversary committees were received.

D. T. MacDougal was elected to membership.

The Secretary reported $81 collected from 32 persons.

The Treasurer reported $4.64 on hand January 1, 1897, and received during 1897 $81; total of $85.64. Bills had been paid during the year of $79.15, leaving a balance of $6.49 on hand. But bills amounting to considerably more than this balance remained unpaid.

The Curator of the museum reported the condition of the museum, the effort he had made to receive and label the collections, the large number of daily visitors and the great interest shown.

Report of the Corresponding Secretary of accessions to the Library received during 1897:

Agram, Hungary.—Jugoslavenska Akademija: Ljetopis, Vol. XI; Rad, Vols. XXII, XXIII.

Agricultural College, Mich.—Michigan Agricultural College and Exp. Station: Bulletin Nos. 135-144.

Albany, N. Y.—State Library: Annual Report, 1895; Bulletin, Nos. 7, 8.

State Museum: Annual Report, 1895; Bulletin.

University of New York: Regents' Report, 1896.

Altenburg, Germany.—Naturforschende Gesellschaft des Osterlandes: Mitteilungen, Vol. VII.

Austin, Texas.—Texas Academy of Science: Transactions, Vol. II: 1.

Baltimore, Md.—Johns Hopkins University: Circular, Nos. 128-131.

Belfast, Ireland.—Natural History and Philosophical Society: Report and Proceedings, 1895-1896.

Berlin, Germany.—R. Friedländer und Sohn. Naturæ novitates, 1896: 20-24; 1897: 1-8.

Bombay, India.—Royal Asiatic Society: Journal, Vol. XIX, No. 53; Memoirs, Vols. XVI, XXVI.

Bône, Algeria.—Academia d' Hippone: Comptes Rendus, 1896.

Boston, Mass.—American Academy of Arts and Sciences: Proceedings, Vol. xxxii.

Boston, Mass.—Horticultural Society: Transactions, 1896.

Bremen, Germany.—Naturwissenschaftlicher Verein: Abhandlungen, Vol. xiv: 1.

Brisbane, Queensland.—Geological Survey of Queensland: Bulletin, Nos. 5, 6.

Brisbane, Queensland.—Royal Society of Queensland: Proceedings, xii.

Brünn, Austria.—Naturfoschender Verein: Bericht, Vol. 14; Verhandlungen, Vol. xxxiv.

Bruxelles, Belgium.—Société Belge de Microscopie: Annales, Vol. xxi. Bulletin, Vol. xxiii.

Bruxelles, Belgium.—Société Royale de Botanique de Belgique: Bulletin, Vols. xxxv, xxxvi.

Buenos Aires, Argentine.—Sociedad Cientifica Argentina: Annales, Vols. xlii, xliii.

Calcutta, India.—Geological Survey of India: Memoirs, Vol. xxv; Records, Vol. xxix: 4.

Cambridge, Mass.—Harvard College Observatory: Annals, Vols. xxv: 2; xxxvi; xxxviii.

Cambridge, Mass.—Museum of Comparative Zoology: Annual Report, 1897; Bulletin, Vols. xxxi: 1-5; xxxii: 1-9.

Chapel Hill, N. C.—Elisha Mitchell Scientific Society: Journal, Vol. xiii.

Chicago, Ill.—Chicago Academy of Sciences: Annual Report, 40th; Bulletin, Vol. ii, Nos. 1, 2.

Chicago, Ill.—Field Columbian Museum: Publications, Nos. 15-22; 24.

Chicago, Ill.—Journal of Geology: Journal, Vol. v.

Christiania, Norway.—Videnskabs Selskab: Förhandlinger, 1896; Skrifter, 1895.

Cincinnati, Ohio.—Cincinnati, Society of Natural History: Journal Vol. xix: 2, 3.

Denver, Col.—Colorado Scientific Society: Ferric Sulphate, etc.; Circular, No. 1.

Des Moines, Iowa.—Geological Survey of Iowa: Annual Report, Vol. vii.

Des Moines, Iowa.—Iowa Academy of Science: Proceedings, Vol. iii.

Dorpat, Russia.—Naturforscher Gesellschaft bei der Universität: Sitzungsberichte, Vol. xi.

Ekaterinburg, Russia.—Société Ouralienne des Amis des Sciences Naturelles: Bulletin, Vols. xiv: 5; xv.; Memoirs, Vols. xiv, xv.

Emden, Germany.—Naturforschende Gesellschaft: Jahresbericht, Vol. lxxxi.

Genéve, Switzerland.—Société de Geographi: Le Globe, Vol. xxxvi.

Graz, Austria.—Naturwissenschaftlicher Verein: Mitteilungen, Vol. xxxiii.

Gueret, France.—Société des Sciences Naturelles: Memoirs, 1895-'96.

Guströw, Germany.—Verein der Freunde der Naturgeschichte: Archiv, Vol. L.

Halifax, Nova Scotia.—Nova Scotia Institute of Science: Proceedings and Transactions, Vol. IX: 2.

Halle a d Saale, Germany.—Kais. Leopold. Carol. Akademie. Leopoldiana, 1896.

Harlem, Netherlands.—Musee Teyler: Archives, Vol. V: 3, 4.

Hermannstadt, Austria.—Siebenburgischer Verein fur Naturwissenschaften, Verhandlungen, Vol. XLV.

Iowa City, Iowa.—Iowa Historical Society: Historical Record, Vol. XIII.

Kharkow, Russia.—Société Naturalistes a l'Universite: Travaux, Vol. XXX.

Kjöbenhavn, Denmark.—Naturhistoriske Förening: Meddelelser, 1896.

Krakowie, Austria.—Akademie der Wissenschaften: Rosprawy, Vols. X-XII.

Lansing, Mich.—State Agricultural College: Bulletin Exp. Station, Nos. 139-144.

Lausanne, Switzerland.—Société Vandoise des Sciences Naturelles: Bulletin, Vols. XXXII, XXXIII.

Lawrence, Kans.—Kansas State University: Geological Survey, Reports, Vols. I, II. Quarterly, Vol. VI.

Lincoln, Neb.—University of Nebraska: University Studies, Vol. II: 2.

Liverpool, England.—Geological Society: Proceedings, Vol. VII: 4.

Manchester, England.—Literary and Philosophical Society: Memoirs and Proceedings, 1896.

Montevideo, Urguay.—Museo Nacional: Annales, Vol. II: 6, 7.

Moskva, Russia.—Imp. Moscow Society of Naturalists: Bulletin, 1896.

Nantes, France.—Société Académique de la Loire-Inferieure: Annales, Vol. VII.

Nashville, Tenn.—State Board of Health: Bulletin, Vols. XII: 5, 6; XIII: 1, 2,.

New York, N. Y.—American Geographical Society: Bulletin, Vols. XXVIII: 4; XXIX.

New York, N. Y.—New York Microscopal Society: Journal, Vols. XIII: 4; XIV: 1.

Oberlin, Ohio.—Oberlin College: Laboratory Bulletin, Nos. 5, 6, 7, 9. Wilson Bulletin, Vol. IV.

Osnabrück, Germany.—Naturwissenschaftlicher Verein: Jahresbericht, 1896.

Paris, France.—Museum d' Histoire Naturelle: Bulletin, 1897.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, 1897.

Philadelphia, Pa.—Zoological Society: Annual Report, 24, 25.

Portland, Maine.—Portland Society of Natural History: Proceedings, Vol. II: 4.

Port Louis, Mauritius.—Royal Alfred Observatory: Meteorological Observations, 1895.

Riga. Russia.—Naturforscherverein: Korrespondenzblatt, Vol. XXXIX.
Roverto. Austria—Accademia degli Agiati in Rovereto: Atti, Vol. II: 4.
Sacramento. Cal.—California State Mining Bureau: Report, Vol. XIII; Bulletin, Nos. XI, XII.
St. Gall, Switzerland.—Naturwissenschaftliche Gesellschaft: Bericht, 1894-1895.
St. John's, New Brunswick.—Natural History Society: Bulletin, Vol. XIV.
Saint-lô, France.—Société d' Agriculture et d' Histoire Naturelle de la Manche. Memoirs et Docum, Vol. XIV.
St. Louis, Mo.—Missouri Botanical Garden: Annual Report, Vol VII.
St. Louis, Mo.—St. Louis Academy of Science: Transactions, Vol. VII: 10-16.
St. Paul, Minn.—Minnesota Historical Society: Historical Collections, Vol. VII: 1, 2.
Sankt Peterburg. Russia.—Imp. Academy of Sciences: Bulletin, Vol. IV.
Sankt Peterburg, Russia.—Geological Committee: Bulletin, Vol. XV: 3-5; Memoirs, Vols. XIV: 2, 4; XV: 2.
Sankt Peterburg. Russia.—Société Imp. Mineralogique: Verhandlungen, 1895.
San Francisco, Cal.—California Academy of Sciences: Proceedings, Vol. VI; New Ser., Vol. I: 1-3.
Sydney, New South Wales.—Geological Survey of New South Wales: Annual Report, 1896; Records, Vol. V: 1.
Stockholm, Sweden.—Kongl. Svenska Vetenskaps-Akademien: Bihang, Vol. XXI; Oversight, 1896.
Topeka, Kans.—Kansas Academy of Sciences: Transactions, Vol. XIV.
Torino, Italy.—Museo Zoologico di Torino: Bulletin, Vol. XI
Toronto, Canada.—Canadian Institute: Proceedings, Nos. 1, 2; Transactions, Vol. V: 1.
Toulouse, France.—Société Française de Botanique: Revue, Vol. XIII.
Urbana, Ill.—Illinois State Laboratory of Natural History: Bulletin, Vol. V: 1, 2, 5.
Washington, D. C.—Bureau of American Ethnology: Annual Report, Vol. XIV, XV.
Washington, D. C.—United States Geological Survey: Annual Report, Vols. XVI, XVII; Bulletin, Nos. 87, 127, 130, 135, 136, 138-148. Monographs, Vols. XXIII, XXV-XXVIII.
Washington, D. C.—United States National Museum: Bulletin, Vol. XLIX; Proceedings, Vol. XIX.
Washington, D. C.—Patent Office: Official Gazette, Vols. LXXIX-LXXXI.
Washington, D. C.—Weather Bureau: Monthly Weather Review, 1897.
Zurich, Switzerland.—Naturforschende Gesellschaft: Vierteljahrschrift, Vols. XLI: 3, 4; XLII: 1, 2.

Officers elected as follows:

President, - - - - - - -	Professor N. H. Winchell.
Vice President, - - - -	Dr. D. T. MacDougal.
Recording Secretary,- - - -	A. D. Roe.
Corresponding Secretary, - -	C. P. Berkey.
Treasurer, - - - - - - - -	E. C. Gale.
Trustees for three years, -	E. C. Gale. C. P. Berkey.
Trustee to succeed H. W. Smith	Dr. H. T. Eddy.

241st Meeting, April 5, 1898.

Nine persons present.

Vice President MacDougal presiding.

G. B. Aiton, U. S. Cox, and C. E. Bond were elected to membership.

A box of specimens and a letter from Hon. Frank Ives, with promise of his report as delegate to the International Congress of Geologists at St. Petersburg, was duly received and ordered acknowledged.

The following amendment to Section I, Article I of the By-Laws, duly announced at the last meeting, was adopted. "The annual meeting of the Academy shall be held on the first Tuesday after the first Monday in January. The regular meetings of the Academy shall be held on the first Tuesday after the first Monday in the months of January, April and October in each year. Five members shall constitute a quorum."

The invitation of the Mankato Board of Trade to hold a special meeting of the Academy in that city was accepted; a committee, Drs. MacDougal and Sardeson, was empowered to use what money was necessary up to $25, for incidental expenses.

242d Meeting, January 3, 1899.

ANNUAL MEETING.

Twelve persons present; Vice President MacDougall presided.

The following were elected to membership:

Dr. J. K. Hosmer and F. J. Warvelle of Minneapolis.

Oscar Halvorson, Two Harbors.

H. F. Burchard, St. Paul.

The reports of the Secretary and Treasurer showed a balance in the treasury at the beginning of the year of $6.49, receipts $64.92; disbursements $65.91. Balance now in treasury, $5.51 with no debts.

The report of the Corresponding Secretary was omitted. (See pages 221-7).

Officers were elected as follows:

President, - - - - - - - - Prof. D. T. MacDougal.
Vice President, - - - - - - O. W. Oestlund.
Recording Secretary, - - - A. D. Roe.
Corresponding Secretary, - - C. P. Berkey.
Treasurer, - - - - - - - E. C. Gale.
Trustees for three years, - { C. W. Hall.
H. T. Eddy.

Program: Terrace Gravels about St. Anthony Falls, by F. W. Sardeson.

[ABSTRACT.]

The occurrence of terraces younger than the Glacial drift and older than St. Anthony falls and gorge of the Mississippi river was indicated with considerable detail. In particular a terrace gravel containing shells of mollusks 100 feet above the present level of the river below the falls was described and specimens were exhibited. This occurrence has been described by Hall and Sardeson, Bulletin Geological Society Am. Vol. x, p. 358 and Fig. 2, November, 1899.

Unusual Occurrences of Copper in Minnesota, by C. P. Berkey.

Antennal Sense Organs of the Aphididae, by O. W. Oestlund.

[ABSTRACT.]

Attention was called to the great variety of sense organs on the antennæ of the Aphididæ, and their value for distinguishing species. The most conspicuous are the so called sensoria, small membranous areas scattered over the surface. Of these three distinct types may be distinguished: 1. *Apical Sensoria*, a single large sensoria close to the apex of the fifth and the sixth joints. The first to appear in the larvæ and the most constant sensoria present. 2. *Marginal Sensoria*, a group of very small sensoria near the margin of the apical sensoria of the sixth joint. 3. *Circular Sensoria*, more or less scattered over the surface of the third and sometimes also on the fourth and fifth joints. The circular sensoria show considerable variation in the different genera, and may be transverse, annulate, tuberculate, etc.

The hairs of the antennae are also undoubtedly sense organs, of which several different forms may be distinguished: 1. A group of short spine-like hairs on the apex of the spur, (the narrow prolongation of the sixth joint). 2. Hairs scattered over the surface of the antennæ, long and slender in *Lachnus Chaitophorus*, etc.; short and spine-like in *Aphis*; club-shaped in *Nectarophora*.

A Mineral Resembling Meerschaum, from the Serpentine Range of Hampden County, Mass., by A. D. Roe. [See paper J.]

The Sugar Beet Industry at St. Louis Park, by C. C. Hafer.

243d Meeting, April 4, 1899.

Eleven present; President MacDougal in the chair.

John Skinner elected to membership.

A committee, Dr. J. K. Hosmer, Dr. F. W. Sardeson, and A. D. Roe, was appointed to consider paying a curator of the Academy museum.

The President reported informally on the proposition of the Omaha Exposition corporation for the mounting, exhibition, and subsequent return to the Academy at this city of the Menage Philippine Expedition material stored at the State University buildings.

Brief papers were read by Dr. F. W. Sardeson and Dr. U. S. Grant.

244th Meeting, October 3, 1899.

President Oestlund in the chair.

Ten persons present.

The disposition of the collections of the Menage Expedition to the Philippine Islands on their return from Omaha, was considered. A committee was appointed, consisting of Messrs. Roe, Winchell and Burchard.

The following program of papers was presented:

A Theory of the Origin of Copper in the Lake Superior district, by C. P. Berkey.

River Collecting of Zoological Material, by J. E. Guthrie.

The chairman was authorized to arrange for a series of popular meetings.

245th Meeting, January 2, 1900.

ANNUAL MEETING.

Ten persons present.

The Secretary presided.

Dr. C. P. Berkey gave a lecture on Cripple Creek and Aspen; their Geology, Mining, History, and Scenery.

[ABSTRACT.]

The paper presented was the result of a trip to these camps as a member of the field expedition of the School of Mines of the University of Minnesota. The geologic structure of each camp was outlined, its history as a producing camp was sketched, and these features together with the magnificent scenery of these mountainous districts was illustrated by a series of photographs and lantern slides. A series of the characteristic ores and rock types of the districts was exhibited.

246th Meeting, February 5, 1900.

ADJOURNED ANNUAL MEETING.

Room 21 Pillsbury Hall.

Six persons present.

Vice President Oestlund presiding.

The Recording Secretary reported $57 dues collected.

A. D. Roe, elected curator by the board of trustees, reported that the Philippine exhibit was opened at the Academy Museum on Nov. 5, 1899, with an admission fee of ten cents, children under 12, five cents, and that the receipts for the nine weeks from Nov. 5, 1899, to Feb. 5, 1900, had been $358.85. He had turned over $280 of this to the Treasurer.

Report of the Corresponding Secretary of exchanges received for the two years, 1898 and 1899:

Agram, Hungary.—Jugoslavenska Akademija: Ljetopis, Vols. XII, XIII; Rad, Vols. XXIV, XXV.

Albany, N. Y.—State Library: Annual Report, Vols. LXXIX, LXXX; Bulletin, Nos. 9-12.

State Museum: Annual Report, Vols. L, LI; Bulletin, , Vols. IV: 16-19; V: 20-23.

University of New York: Regents' Report, 1897, 1898.

Amiens, France.—Société Linnéenne du Nord de la France: Bulletin, Nos. 283-302; Memoirs, Vol. IX.

Austin, Texas.—Texas Academy of Science: Transactions, Vol. I: 4

Baltimore, Md.—Johns Hopkins University: Circular, Nos. 132-141.

Barcelona, Spain.—Real Academia di Ciencias y Artes: Bulletin, Vol. I: 15-23; Nomina, 1898-1899.

Basel, Switzerland.—Naturforschende Gesellschaft: Verhandlungen, Vols. XI: 3; XII: 1.

Belfast, Ireland—Natural History and Philosophical Society: Report and Proceedings, 1896, 1897.

Berlin, Germany.—R. Friedländer und Sohn. Naturæ novitates, 1897, Nos. 9-20; 1898, 1899.

Béziers, France.—Société d' Etude des Sciences Naturelles: Bulletin, Vols. XIX, XX.

Bologna, Italy.—Accademia delle Scienze dell' Instituto di Bologna: Memoirs, Vols. V, VI; Rendus delle Sess, Vol. I.

Bombay, India.—Royal Asiatic Society: Journal, Vol. XX; No. 54.

Bône, Algeria.—Academie d' Hippone: Comptes Rendus, 1897, 1898; Bulletin No. 29.

Boston, Mass.—American Academy of Arts and Sciences: Proceedings, Vols. XXXIII, XXXIV.

Boston, Mass.—Boston Society of Natural History: Proceedings, Vol. XXVIII.

Boston, Mass.—Horticultural Society: Transactions, 1897, 1898.

Bremen, Germany.—Naturwissenschaftlicher Verein: Abhandlungen, Vols. XIV: 2; XV; XVI.

Brisbane, Queensland.—Geological Survey of Queensland: Bulletin, Nos. 8-10.

Brisbane, Queensland.—Royal Society of Queensland: Proceedings, Vol. XIII.

Brünn, Austria.—Naturforschender Verein: Bericht, Vols. XV, XVI; Verhandlungen, Vols. XXXV, XXXVI.

Bruxelles, Belgium.—Société de Géologie: Bulletin, Vols. VII, VIII, IX.

Bruxelles, Belgium.—Société Belge de Microscopie: Annales, Vols. XXII, XXIII; Bulletin, Vol. XXIV.

Bruxelles, Belgium.—Société Malacologique de Belgique: Proces Verbal, Nos. 25-27; Bulletin, No. 34.

Buenos Aires, Argentine.—Instituto Geographico Argentino: Bulletin, Vols. XVIII, XIX, XX: 1-6.

Buenos Aires, Argentine—Museo Nacional: Anales, Vols. V, VI; Com's. Vol. I: 1-3; Memores, 1894, 1895, 1896.

Buenos Aires, Argentine.—Sociedad Cientifica Argentina: Anales, Vols. XLIV, XLVII.

Calcutta, India.—Geological Survey of India: Memoirs, Vols. XXVII: 2: XXVIII: 1 Records.

Cambridge, Mass.—Museum of Comparative Zoology: Annual Report, 1898, 1899; Bulletin, Vols. xxxii-xxxv.

Cape Town, South Africa.—South African Philosophical Society: Transactions, Vols. ix, x.

Cardiff, England.—Naturalists' Society: Report and Transactions, Vols. xxix, xxx.

Catania, Italy.—Accademia Gioenia di Scienze Naturali: Bulletin, Nos. 48-59.

Chapel Hill, N. C.—Elisha Mitchell Scientific Society: Journal, Vols. xiv, xv.

Chicago, Ill.—Field Columbian Museum: Annual Report, 1897, 1898; Birds of Eastern N. America, Part 1; Publications, Nos. 25, 33-43, 46-50.

Chicago, Ill.—John Crerar Library: Annual Report, 4th.

Chicago, Ill.—Journal of Geology: Journal, Vols. vi, vii.

Christiania, Norway.—Videnskabs Selskab: Förhandlingar, 1897, 1898; Oversigt, 1898; Skrifter, 1896, 1897, 1898.

Cincinnati, Ohio.—Cincinnati Society of Natural History: Journal, Vol. xix: 4.

Denver, Col.—Colorado Scientific Society: Bulletin, Nos. 3, 4.

Des Moines, Iowa.—Geological Survey of Iowa: Annual Report, Vols. viii, ix.

Des Moines, Iowa.—Iowa Academy of Sciences: Proceedings, Vols. iv, v.

Dorpat, Russia.—Naturforscher Gesellschaft bei der Universität: Sitzungsberichte, Vol. xii: 1.

Ekaterinburg, Russia.—Société Ouralienne des Amis des Sciences Naturelles: Bulletin, Vols. xvi, xvii, xviii, xix.

Emden, Germany.—Naturforschende Gesellschaft: Jahresbericht, Vol. lxxxii; Kleine Schriften, Vol. xix.

Firenze, Italy.—Biblioteca Nazionale Centrale: Bulletin, Nos. 280-331.

Frankfurt a d Oder, Germany.—Naturwissenschaftlicher Verein, Helios, Vols. xiv, xv, xvi; Societatum Litteræ, Vols, xi, xii, xiii.

Genève, Switzerland.—Société de Géographie: Bulletin, 1898; Le Globe, Vols. xxxvii, xxxviii.

Georgetown, British Guiana.—Royal Agricultural and Commerical Society: Journal, Vol. xi.

Glasgow, Scotland.—Natural History Society of Glasgow: Proceedings, Vol. v: 1, 2.

Görlitz, Germany.—Naturforschende Gesellschaft: Abhandlungen, Vol. xxii.

Granville, Ohio.—Denison University: Bulletin, Vols. viii, ix, x; xi: 1-8.

Greifswald, Germany.—Naturwissenschaftlicher Verein: Mittellungen, Vols. xxviii, xxix.

Guéret, France.—Société des Sciences Naturelles de la Creuse: Memoirs, 1897, 1898.

Guströw, Germany.—Verein der Freunde der Naturgeschichte: Archiv, Vols. li, lii.

Habana, Cuba.—Academia di Ciencias: Anales, Vols. xxxv, xxxvi, Nos. 418-420.

Halifax, Nova Scotia.—Nova Scotia Institute of Science: Proceedings, Vol. xix: 3, 4.

Halle a d Saale, Germany.—Kais. Leopold. Carol. Akademie. Nova Acta, Vols. lxx: 3; lxxi: 9; Leopoldiana, 1898.

Hannover, Germany.—Naturhistorische Gesellschaft: Jahresbericht, Vols. xliv-xlvii.

Harlem, Netherlands.—Musée Teyler: Archives, Vol. vi: 1-6.

Innsbruck, Austria.—Naturwissenschaftlich-Medizinischer Verein: Bericht, Vol. xxiii, xxiv.

Iowa City, Iowa.—Iowa Historical Society: History of Iowa, Vol. ii; Records, Vols. xiv, xv.

Kassel, Germany.—Verein für Naturkunde: Abhandlungen, Vols. xlii, xliii.

Kharkow, Russia.—Société Naturalistes a l' Universite: Travaux, Vol. xxxi.

Kiel, Germany.—Naturwissenschaftlicher Verein: Schriften, Vol. xi. No. 1.

Kjöbenhaven, Denmark.—Naturhistorike Förening: Meddelelser, 1897, 1898.

Krakowie, Austria.—Akademie der Wissenschaften: Rosprawy, Vols. xiii, xiv.

Landshut, Germany.—Botanischer Verein: Bericht, Vol. xv.

Lansing, Mich.—State Agricultural College: Bulletin Exper. Station, Nos. 145-168.

Lausanne, Switzerland.—Société Vandoise des Sciences Naturelles: Bulletin, Vol. xxxiv.

Lawrence, Kans.—Kansas State University: Quarterly, Vols. vii, viii; Bulletin, Vol. i: 1-3.

Liege, Belgium.—Société Géologique de Belgique: Annales, Vols. xxii, xxiii, xxiv, xv.

Liverpool, England.—Geological Society: Proceedings, Vol. viii: 1, 2.

Lüneberg, Germany.—Naturwissenschaftlicher Verein: Jahresbericht, Vol. xiv.

Manchester, England.—Manchester Literary and Philosophical Society: Memoirs and Proceedings, Vols. xlii; xliii: 1-4.

Melbourne, Victoria.—Public Libray, Museum and National Gallery: Reports, 1896-1897.

Milano, Italy.—Società Italiana di Scienze Naturali: Atti, Vol. xxxvii.

Milwaukee, Wis.—Public Museum: Annual Report, Vols. xv, xvi.

Montevideo, Uruguay.—Museo Nacional Anales, Vols. ii: 8-11; iii: 9-10.

Montreal, Canada.—Canadian Record of Science: Vols. vii: 6, 7, 8; viii: 1.

Moskva, Russia.—Imp. Moscow Society of Naturalists: Bulletin, Vols 1897: 1-4; 1898.

Nantes, France.—Société Académique de la Loire-Inferieure: Annales, Vol. VIII.

Neuchâtel, Switzerland.—Société des Sciences Naturelles: Bulletin, Vols. XXI-XXV.

New York, N. Y.—American Geographical Society: Bulletin, Vols. XXX, XXXI.

New York, N. Y.—American Museum of Natural History: Bulletin, Vols. X, XI.

New York, N. Y.—Linnean Society: Abstracts, Nos. 8-11.

Nürnberg, Germany.—Naturhistorische Gesellschaft: Abhandlungen, Vol. XI.

Oberlin, Ohio.—Oberlin College: Wilson Bulletin, Vols. V; VI: 1-4; Library Bulletin, No. 4.

Osnabrück, Germany.—Naturwissenschaftlicher Verein: Jahresbericht, 1897, 1898.

Ottawa, Canada.—Geological and Natural History Survey of Canada: Annual Report, Vols. VIII and XIX, with maps.

Padova, Italy.—Società Veneto-Trentina di Scienze Naturali: Atti, Vol. III: 2; Bulletin, VI: 3.

Paris, France.—Museum d' Histoire Naturelle: Bulletin, 1898, 1899.

Penzance, England.—Royal Geological Society of Cornwall: Transactions, Vol. XII: 4.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, Vols. 1898, 1899.

Philadelphia, Pa.—Wagner Free Institut of Science: Transactions, Vol. III: 4.

Philadelphia, Pa.—Zoological Society of Philadelphia: Annual Report, Vols. XXVI, XXVII.

Pisa, Italy.—Società Toscana di Scienze Naturali: Atti, Vol. XI.

Port Louis, Mauritius.—Royal Alfred Observatory: Annual Report, 1896, 1897.

Prag, Bohemia.—Böhmische Gesellschaft der Wissenschaften: Jahresbericht, 1896-1898; Sitzungsberichte, 1896-1898.

Reichenberg, Bohemia.—Verein der Naturfreunde: Mitteilungen, Vols. XXVII-XXX.

Rovereto, Austria.—Accademia degli Agiati in Rovereto: Atti, Vols. III, IV, V: 1-2.

St. Gall, Switzerland.—Naturwissenschaftliche Gesellschaft: Bericht, 1896, 1897.

St. John's, New Brunswick.—Natural History Society: Bulletin, Vols. XVI, XVII.

Saint-lô, France.—Société d' Agriculture et d' Histoire Naturelle de la Manche: Memoirs & Docum., Vols. XV, XVI.

St. Louis, Mo.—Missouri Botanical Garden: Annual Report, Vols. VIII, IX.

St. Louis, Mo.—St. Louis Academy of Science: Transactions, Vols. VII: 17-20; VIII; IX: 1-4.

St. Paul, Minn.—Minnesota Historical Society: Biennial Report, Vol. x.

Sankt Peterburg, Russia.—Imperial Academy of Sciences: Bulletin, Vols. v, vi; Memoirs, Vol. iv: 3.

Sankt Peterburg, Russia.—Geological Committee: Bulletin, Vols. xv, xvi; Memoirs, Vol. xvi: 1.

San Francisco, Cal.—California Academy of Sciences: Proceedings, Vol. i: 4, 5, 6, 11, 12; Occasional Papers, Vol vi.

Santiago, Chile.—Société Scientifique du Chile: Actes, Vol. vii: 2, 3, 4.

Sydney, New South Wales.—Australian Museum: Report, 1897, 1898; Records, Vol. iii: 3-5.

Stavanger, Norway.—Stavanger Museum: Aarsberetning, 1898-1899.

Stockholm, Sweden.—Geologiska Byron: Afhandlingar, Nos. C. 160-182.

Stockholm, Sweden.—Kongl. Svenska Vetenskaps-Akademien: Bihang, Vols. xxii-xxiv; Ofversigt, 1897, 1898.

Sydney, New South Wales.—Geological Survey of New South Wales: Annual Report, 1897, 1898; Mineral Resources, Nos. 5, 6; Records, Vols. vi: 2, 3; vii: 1.

Sydney, New South Wales.—Royal Society: Journal and Proceedings, Vols. xxx, xxxi, xxxii.

Thorn, Germany.—Copernicus Verein für Wissenschaft und Kunst: Jahresbericht, 1897; Mitteilungen, Vols. x-xii.

Tokio, Japan.—Deutsche Gesellschaft für Natur und Völkerkunde: Mitteilungen, Vol. vi, Nos. 58-60.

Torino, Italy.—Museo Zoologico di Torino: Bulletin, Vols. xii, xiii.

Toronto, Canada.—Canadian Institut: Proceedings, Vols. i: 6; ii: 1, 2; Transactions, Vol. v: 2.

Toulouse, France.—Académie des Sciences: Memoirs, Vols. viii, ix; Bulletin, Vol. i.

Upsala, Sweden.—Geological Institute University of Upsala: Bulletin, Vols. iii, iv: 1.

Urbana, Ill.—Illinois State Laboratory of Natural History: Bulletin, Vol. v: 4, 5.

Washington, D. C.—United States Geological Survey: Annual Report, Vol. xviii; Bulletin, Nos. 51, 88, 89, 149; Monographs, Vols. xxix, xxx, xxxi, xxxv.

Washington, D. C.—United States National Museum: Bulletin, Vol. xlvii: 2, 3; Proceedings, Vols. xx, xxi.

Washington, D. C.—Patent Office: Official Gazette, Vols. lxxxii-lxxxviii.

Washington, D. C.—Smithsonian Institution: Annual Report, 1896-1897.

Washington, D. C.—United States Weather Bureau: Monthly Weather Review, Vols. xxvi, xxvii.

Winnipeg, Manitoba.—Manitoba Historical and Scientific Society: Annual Report, 1896-1898; Transactions, Vol. xlix, liv.

Zurich, Switzerland.—Naturforschende Gesellschaft: Vierteljahrschrift, Vols. xlii: 3, 4; xliii; xliv: 1, 2.

Zwickau, Germany.—**Verein für Naturkunde: Jahresbericht, 1895, 1896.**

American Association for the Advancement of Sciences: Proceedings, Vols. XLVI, XLVII.

Election of officers:
President, - - - - - Dr. H. T. Eddy.*
Vice President, - - - - - - O. W. Oestlund.
Recording Secretary, - - - F. G. Warville.
Corresponding Secretary, - - C. P. Berkey.
Treasurer, - - - - - - - - E. C. Gale.
Trustees for three years, - Dr. J. K. Hosmer.
A. D. Roe.

247th Meeting, April 8, 1900.

Thirty-two persons present.

Vice President Oestlund in the chair.

Dr. Berkey reported that material had been sent to the Duluth Scientific Association and Moorhead Normal School.

Curator Roe reported that free Saturday admission to the museum had reduced receipts, but that March still gave a profit of $16.

H. W. Howling, Wm. Kilgore, Alfred Humphrey, J. H. Gill, and Paul M. Glasoe were elected to membership.

Program:

The Bad Lands of Wyoming, by F. W. Sardeson, illustrated by original photographs taken by his expedition of last year to Big Horn county.

Personal Observations on Ants, by O . W. Oestlund.

[ABSTRACT.]

An account of an observation on ants was given that seems to be exceptional, or at least not recorded by any student on the habits of ants as far as can be ascertained by the author.

A nest found on a burnt-over place on the border of the woods had a space of smooth and hard ground around it, about a foot in diameter, free from grass or any vegetation. The whole colony, of 150 to 200 individuals, was apparently above ground on the open space. The ants showed great excitement and were running about in all directions. Their actions appeared at first to be aimless, due to fear, danger or some other cause that had thrown the whole colony in commotion. But on closer observation it was seen that when two of them met they would clasp antennæ and forelegs and rise up on the hind legs, would swing around two or three times, on which they would separate, each one going in search for a new partner to repeat the same action.

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*Dr. Eddy declined to serve as President of the Academy and Vice President Oestlund was Acting President for the year.—EDITOR.

The interpretation given to this unusual procedure was that the ants were at play, or, to express it as man would, they had a dance.

248th Meeting, October 2, 1900.

Ten persons present.

Vice President Oestlund presided.

Program:

The Geology of the Pembina Mountains, by C. P. Berkey, with specimens of brick made from their sand.

Glacial Plowing in the Vicinity of Minneapolis, by F. W. Sardeson.

[ABSTRACT.]

This paper is based on a series of observations made during excavation of Glacial drift. The results to date were shown by aid of photographs. This paper with drawings instead of reproduced photographic illustrations has been published elsewhere. ("A Particular Case of Glacial Erosion," The Journal of Geology, Vol. XIII. No. 4, p. 351-357, May-June, 1905.)

249th Meeting, November 13, 1900.

Thirteen present.

Vice President Oestlund presiding.

Program: Surface Features of Minnesota, by C. W. Hall.

250th Meeting, December 4, 1900.

About fifteen present.

Vice President Oestlund presiding.

Program:

A demonstration of original micro-photographs as lantern slides, showing the late progress in finer anatomy and in the physiology of the brain, by Harlow Gale.

251st Meeting, January 8, 1901.

ANNUAL MEETING.

Twelve present.

Vice President Oestlund presiding.

Corresponding Secretary Berkey reported the year's accessions to the library as 371 domestic and 417 foreign publications.

List of exchanges received during the year 1900:

Agram, Hungary.—Jugoslavenska Akademija: Ljetopis, Vol. xiv; Rad, No. 140.

Agricultural College, Mich.—Agricultural College and Exp. Station: Bulletin, Nos. 166-181. Annual Report, 37, 38.

Albany, N. Y.—State Library: Annual Report, 1899.
State Museum: Bulletin, Vols. v: 24, 25; vi: 26-34.
University of New York: Regents' Report, 1899.

Amiens, France.—Société Linnéenne du Nord de la France: Bulletin, Vol. xiv, Nos. 303-322.

Baltimore, Md.—Johns Hopkins University: Circular, Nos. 142-149.

Bamberg, Germany.—Naturforschende Gesellschaft: Bericht, Vol. xvii.

Barcelona, Spain.—Real Academia de Ciencias y Artes: Bulletin, Vol. i: 24-26.

Basel, Switzerland.—Naturforschende Gesellschaft: Verhandlungen, Vol. xii: 2, 3.

Belfast, Ireland.—Natural History and Philosophical Society: Report and Proceedings, 1898-1899.

Berlin, Germany.—R. Friedländer und Sohn: Naturæ Novitates, Vol. xxii.

Béziers, France.—Société d' Etude des Sciences Naturelles: Bulletin, Vol. xxi.

Bologna, Italy.—Accademia delle Scienze dell' Instituto di Bologna: Memoirs, Vol. vii; Rendiconto, Vols. ii, iii.

Bombay, India.—Royal Asiatic Society: Journal, Vol. xx, No. 55.

Bône, Algeria.—Academie d' Hippone: Comptes Rendus, 1899.

Boston, Mass.—American Academy of Arts and Sciences: Proceedings, Vol. xxxv.

Boston, Mass.—Boston Society of Natural History: Proceedings, Vol. xxix.

Boston, Mass.—Horticultural Society: Transactions, 1899.

Brisbane, Queensland.—Royal Society of Queensland: Proceedings, Vols. xiv, xv.

Brünn, Austria.—Naturforschender Verein: Bericht, Vol xvii; Verhandlungen, Vol. xxxvii.

Bruxelles, Belgium.—Société de Microscopie: Annales, Vols. xxiv, xiii.

Bruxelles, Belgium.—Société de Microscopie: Annales, Vols. XXIV, XXV; Bulletin, Vol. XXV.

Bruxelles, Belgium.—Société Royale de Botanique de Belgique: Bulletin, Vols. XXXVII, XXXVIII.

Buenos Aires, Argentine.—Museo Nacional: Com's. Vol. I: 4-6.

Buenos Aires, Argentine.—Sociedad Cientifica Argentina: Anales, Vols. XLVIII, XLIX.

Calcutta, India.—Geological Survey of India: Report, 1899; Record, Vol XXIX; 1; Memoirs, Vols. XXIX, XXX: 1-3; N. S., Vol. I.

Cambridge, Mass.—Harvard College Observatory: Annals, Vols. XXXII: 2, XXXIII; Report, 1899.

Cambridge, Mass.—Museum of Comparative Zoology: Vols. XXXVI: 7, 8; XXXVII: 1, 2; XXXVIII: 1.

Cape Town, South Africa.—South African Philosophical Society: Transactions, Vol. XI: 1.

Cardiff, England.—Naturalists' Society: Report and Transactions, Vol. XXXI.

Catania, Italy.—Accademia Gіœnia di Scienze Naturali: Bulletin, Nos. 60-63.

Chapel Hill, N. C.—Elisha Mitchell Scientific Society: Journal, Vol. XVI.

Chemnitz, Germany.—Naturwissenschaftlicher Gesellschaft: Bericht, Vol XIV.

Chicago, Ill.—Botanical Gazette: Vols XXVIII, XXIX, XXX.

Chicago, Ill.—Chicago Academy of Sciences: Report, Vol. XL; Bulletin, Vol. II: 3.

Chicago, Ill.—Field Columbian Museum: Birds of Eastern N. America, Part 2; Publications, No. 44.

Chicago, Ill.—John Crerar Library: Annual Report, Vol. V.

Chicago, Ill.—Journal of Geology, Vol. VIII.

Christiania, Norway.—Videnskabs Selskab: Forhandlingar, 1899; Oversigt, 1899; Skrifter, 1899.

Chur, Switzerland.—Naturforschende Gesellschaft Graubündens: Jahresbericht, Vols. XLI, XLII.

Cincinnati, Ohio.—Cincinnati Society of Natural History: Journal, Vol. XIX: 5, 6.

College Hill, Mass.—Tufts College: College Studies, Vols. V, VI.

Colorado Springs, Col.—Colorado College: College Studies, Vols. VII, VIII.

Denver, Col.—Colorado Scientific Society: Bulletin, No. 2.

Des Moines, Iowa.—Geological Survey of Iowa: Annual Report, Vol. X.

Dorpat, Russia.—Naturforscher Gesellschaft bei der Universität: Sitzungsberichte, Vol. XII: 2.

Ekaterinburg, Russia.—Société Ouralienne des Amis des Sciences Naturelles: Bulletin, Vol XX.

Emden, Germany.—Naturforschende Gesellschaft: Jahresbericht, Vol. LXXXIII, LXXXIV.

Firenze, Italy.—Biblioteca Nazional Centrale: Bulletin, Nos. 332-356.

Frankfurt a d Oder, Germany.—Naturwissenschaftlicher Verein: Helios, Vol. xvii; Societatum Litteræ, Vol. xiv.

Fribourg, Switzerland.—Société Fribourgeoise des Sciences Naturelles: Bulletin 5, Vol. xvii.

Genève, Switzerland.—Société de Géographie: Le Globe, Vol. xxxix.

Graz, Austria.—Naturwissenschaftlicher Verein: Mitteilungen, Vols. xxxiv-xxxvi.

Guéret, France.—Société des Sciences Naturelles: Memoirs, 1899.

Guströw, Germany.—Verein der Freunde der Naturgeschichte: Archiv, Vol. liii; liv: 1.

Halifax, Nova Scotia.—Nova Scotia Institute of Science: Proceedings and Trans., Vol. x: 1.

Halle a d Saale, Germany.—Kais. Leopold. Carol. Akademie: Abhandlungen, Vol lxxix: 2, 3; Leopoldiana, Vols. xxxv-xxxvii.

Hamburg, Germany.—Verein für Naturwissenschaftliche Unterhaltung: Verhandlungen, Vol. x.

Harlem, Netherlands.—Musée Teyler: Archives, Vols. vi: 4, 5; vii: 1.

Hermannstadt, Austria.—Siebenburgischer Verein für Naturwissenschaften: Verhandlungen, Vols. xlvi, xlvii.

Indianapolis, Ind.—Indiana Academy of Sciences: Proceedings, 1898, 1899.

Iowa City, Iowa.—Iowa Historical Society: Records, Vol. xvi.

Kief, Russia.—Kief Society of Naturalists: Memoirs, Vol. xv, xvi.

Kiel, Germany.—Naturwissenschaftlicher Verein: Schriften, Vol. xi: 2.

Krakowie, Austria.—Akademie der Wissenschaften: Rosprawy, Vols. xv, xvi, xvii.

Lansing, Mich.—State Agricultural College: Bulletin, Nos. 175-181, 185.

Lausanne, Switzerland.—Société Vandoise des Sciences Naturelles: Bulletin, Vol. xxxv.

Le Havre, France.—Société de Géologique de Normandie: Bulletin, Vols. xviii, xix.

Liverpool, England.—Geological Society: Proceedings, Vol. viii: 3.

Madison, Wis.—Wisconsin Academy of Sciences: Transactions, Vol. xi.

Madison, Wis.—Wisconsin Geological and Natural History Survey: Bulletin, No. 6.

Manchester, England.—Manchester Literary and Philosophical Society: Memoirs and Proc., Vols. xliii: 5; xliv.

Melbourne, Victoria.—Public Library: Report, 1898, 1899.

Mexico, Mexico.—Instituto Geologico Nacional: Bulletin, Nos. 12, 13.

Milwaukee, Wis.—Public Museum: Annual Report, Vol xvii.

Minneapolis, Minn.—Geological and Natural History Survey of Minn.: Annual Report, Vol. xxiv; Final Report, Vols. v, vi.

Montevideo, Uruguay.—Museo Nacional: Anales, Vols. ii: 12; xiii: 13, 14.

Montgomery, Ala.—Geological Survey of Alabama: Bulletin, No. 6; Warrior Coal Basin.

Montreal, Canada.—Canadian Record of Science: Vol. VIII: 2-4.

Moskva, Russia.—Imp. Moscow Society of Naturalists: Bulletin 1898: 2, 3, 4; 1899: 1; Memors, Vols. XV: 7; XVI: 1, 2.

Nantes, France.—Société Académique de la Loire-Inferieure: Annales, Vols. IX, X.

Neuchâtel, Switzerland.—Société des Sciences Naturelles: Bulletin, Vol. XXVI.

New York, N. Y.—American Geographical Society: Bulletin, Vol. XXXII.

New York, N. Y.—American Museum of Natural History: Annual Report, 1899; Bulletin, Vol. XII.

Nürnberg, Germany.—Naturhistorische Gesellschaft: Abhandlungen, Vol. XII.

Oberlin, Ohio.—Oberlin College: Laboratory Bulletin, No. 10; Wilson Bulletin, 6: 5, 6.

Ottawa, Canada.—Geological and Natural History Survey of Canada: Annual Report, Vol. X; Notes on Sidney Coal Fields.

Paris, France.—Museum d' Histoire Naturelle: Bulletin, 1900.

Penzance, England.—Natural History and Antiquarian Society: Report and Transactions, 1894-1898.

Penzance, England.—Royal Geological Society of Cornwall: Transactions, Vol. XII: 5.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, 1900.

Philadelphia, Pa.—Zoological Society: Annual Report, Vol. XXVIII.

Pisa, Italy.—Società Toscana di Scienze Naturali: Atti, Vol. XII.

Port Louis, Mauritius.—Royal Alfred Observatory: Annual Report, 1898; Meteorological Observations, 1898.

Regensburg, Germany.—Naturwissenschaftlicher Verein: Berichte, Vols. VI, VII.

Riga, Russia.—Naturforscherverein: Korrespondensblatt, Vols. XL-XLII.

Rio de Janeiro, Brazil.—Museu Nacional: Archivos, Vols. IX, X; Revista, Vol. I.

Rochester, N. Y.—Rochester Academy of Natural Sciences: Proceedings, Vol. III.

Rovereto, Austria.—Accademia degli Agiati en Rovereto: Atti, Vols. V: 3, 4; VI: 1, 2.

Sacramento, Cal—California State Mining Bureau: Bulletin, Nos. 13, 14, 16.

St. Gall, Switzerland.—Naturwissenschaftliche Gesellschaft: Bericht, 1898.

St. John's, New Brunswick.—Natural History Society: Bulletin, Vol. XVIII.

Saint-lô, France.—Société d' Agriculture et d' Historie Naturelle de la Manche. Memoirs & Docum., Vol. XVII.

St. Louis, Mo.—Missouri Botanical Garden: Annual Report, Vols. X, XI.

St. Louis, Mo.—St. Louis Academy of Sciences: Transactions, Vols. IX: 5-9; X: 1-7.

Sankt Peterburg, Russia.—Imp. Academy of Sciences: Bulletin, Vols. VII-XI; Memoirs, Vols. VI: 2: VII: 1; VIII: 2, 6, 7, 10; IX: 1, 2, 6, 8, 9; X: 1, 2.

Sankt Peterburg, Russia.—Geological Committee: Bulletin, Vols. XVII: 6-10; XVIII: 1-10; Memoirs, Vols. VII: 3, 4; VIII: 4; IX: 5; XII: 3; XV: 3.

Sankt Peterburg, Russia.—Imp. Minerological Society: Verhandlungen, Vols. XXXVI, XXXVII.

San Francisco, Cal.—California Academy of Sciences: Proceedings, Vol. II: 2, 3; Occasional Papers, Vol. VII.

Santiago, Chile.—Société Scientifique du Chile: Actes, Vols. IX: 4, 5; X: 1.

Sydney, New South Wales.—Australian Museum: Records, Vol. III: 6-8.

Sydney, New South Wales.—Geological Survey of New South Wales: Mineral Resources, Nos. 7, 8; Records, Vol. IV: 4.

Sydney, New South Wales.—Royal Society of New South Wales: Journal, Vol. XXXIII.

Stockholm, Sweden.—Kongl. Svenska Veteskaps-Akademien: Bihang, Vol. XXV; Oversigt, 1899.

Strassburg, Germany.—Geologischen Landes- Untersuchung. Mitteilungen, Vol. V: 1, 2.

Topeka, Kans.—Kansas Academy of Sciences: Transactions, Vols XV, XVI.

Torino, Italy.—Museo Zoologico di Torino: Bulletin, Vol. XIV.

Toronto. Canada.—Canadian Institute: Proceedings, Vol. II: 3; Transactions, Vol. VI.

Toulouse, France.—Académie des Sciences: Bulletin, Vol. II.

Upsala, Sweden.—Geological Institute University of Upsala: Bulletin, Vol. IV: 2.

Urbana, Ill.—Illinois State Laboratory: Bulletin, Vol. V: 7-11.

Washington, D. C.—U. S. Geological Survey: Annual Report, Vols. XIX, XX; Bulletin, Nos. 157-162; Memoirs, Vols. XXVI, XXXII-XXXVII.

Washington, D. C.—Patent Office: Official Gazette, Vols. LXXXIX-LXLIII.

Washington, D. C.—Weather Bureau: Monthly Weather Review, Vol. XXVIII.

Wiesbaden, Germany.—Naturhistorischer Verein: Jahresbericht, Vols. LI-LII.

Winnipeg, Manitoba.—Manitoba Historical and Scientific Society: Annual Report, 1899; Transactions, Vols. LV, LVI.

Zurich, Switzerland.—Naturforschende Gesellschaft: Vierteljahrschrift, Vols. XLIV: 3, 4; XLV: 1, 2.

American Association for the Advancement of Science: Proceedings, XLVIII.

The following officers were then elected:

President, - - - - - - - - C. W. Hall.
Vice President, - - - - - - O. W. Oestlund.
Recording Secretary, - - - F. G. Warvelle.
Corresponding Secretary, - - C. P. Berkey.
Treasurer, - - - - - - - - - E. C. Gale.
Trustees for three years, - - Dr. T. S. Roberts.
O. W. Oestlund.

Dr. Berkey was instructed to correspond with the officers of the East Side Library in regard to obtaining a permanent home for the Academy library.

252d Meeting, February 5, 1901.

Forty-five members and visitors present.

President Hall in the chair.

Harlow Gale was elected to membership.

The Treasurer's report showed receipts of $592.50; expenses $291.61; balance in treasury $296.99.

The By-Laws were amended so that Sec. II, Art. 2 shall read: "The sections shall cover the following sciences: Astronomy and Mathematics, Botany, Chemistry, Geology, Mineralogy, Physics, Zoology."

Heads of sections were advised to subdivide their sections dependent upon the amount of work being carried on by their associates.

Program:

The Retreat of the Ice Margin across Minnesota, by Professor N. H. Winchell.

Giant Kettles in the Interstate Park, Taylor's Falls, by Warren Upham. (Abstracts of these papers appeared in Science, for March 29, 1901, Vol. xiii, N. S. p. 509).

253d Meeting, April 12, 1901.

Fifty members and visitors present.

E. C. Gale was elected trustee for the unexpired term of C. W. Hall.

F. K. Butters read a paper describing some of the lower forms of plant life emphasizing particularly the fungi and their allies. Illustrated.

254th Meeting, May, 1901.

Lecture room of Chemistry, University of Minnesota.

Seventy-five persons present.

Professor Geo. B. Frankforter gave a lecture on Color Photography, illustrated by many views, diagrams and experiments.

255th Meeting, October 8, 1901.

Directors' room, Public Library.

President Hall presiding.

The thanks of the Academy were voted to the donors of late gifts.

W. F. Decker and W. F. Kunze were elected members.

The program was the experiences of the members during the summer in research work or at the meetings of scientific gatherings. Dr. C. P. Berkey told of his work in Utah, Montana, and Idaho.

Dr. H. T. Eddy spoke of the meetings of the American Mathematical Society and the Institute of Electrical Engineers.

Prof. John Zeleny described the work of the Physics section, A. A. A. S. at Denver; Drs. Frankforter and Harding of the Chemical section; Dr. A. H. Elftman of mining in Colorado.

Prof. E. P. Leavenworth of his research work in Astronomy; A. D. Roe of geodes, and Prof. N. H. Winchell of the Geological section of the A. A. A. S., which brought forth a discussion of Chamberlin's theory of Celestial Mechanics and Van Hise's theory of Ore Deposits.

256th Meeting, January 7, 1902.

ANNUAL MEETING.

Nine present.

President Hall in the chair.

Report of Treasurer E. C. Gale:

By balance from 1900	$ 269.99
By Museum receipts, Mar. 6, 1900, to Mar. 31, 1901	707.65

By Dues	46.00	
	$1,050.54	
April 6—To services for museum, March 6, 1900, to Mar. 31, 1901		$ 577.58
April 6—To services for museum, Mar. 31, 1901, to April 6, 1901		5.50
May 6—To T. H. Colwell for printing bulletin		266.80
May 6—To stamps for bulletin		10.00
May 6—To C. P. Berkey for services		13.20
May 28—To Prof. Hall for sundries		5.35
May 28—To Franklin Printing Co. for Exhibition placards		6.00
May 31—To sundries and postage for Secretary		6.06
Oct. 2—To Franklin Printing Co		3.00
Oct. 2—To Leslie Paper Co		6.13
Jan. 7, 1902—Cash on hand		151.64
		$1,050.64

The Corresponding Secretary reported: "accessions to the library as 292 domestic, 310 foreign publications, total 602. The issue of Vol. iii, Bulletin 3, of the Bulletins was distributed early in the year to members of the Academy and American Institutions; later in the year to foreign societies through the Smithsonian Institution. The Academy library is partly on shelves at the State University, partly in the Public Library, and partly boxed up at the University. Only a small part is available for reference."

Corresponding Secretary's report of accessions during the year 1901:

Agram, Hungary.—Jugoslavenska Akademija: Ljetopis, Vol. xv; Rad, No. 143.

Agricultural College, Mich.—Michigan Agricultural College: Bulletin, Nos. 182-192.

Albany, N. Y.—State Library: Annual Report, 1900.
State Museum: Annual Report, 1898; Bulletin, Nos. 35-42.
University of New York: Regents' Report, 1900.

Amiens, France.—Société Linnéenne du Nord de la France: Bulletin, Nos. 323-332.

Austin, Texas.—Texas Academy of Science: Transactions, Vols. III: IV: 1.

Baltimore, Md.—Johns Hopkins University: Circular, Nos. 150-154.

Bamberg, Germany.—Naturforschende Gesellschaft: Bericht, Vos. XVIII.

Barcelona, Spain.—Real Academia de Ciencias y Artes: Bulletin, Vol. I: 27-30; Nomina Personal, 1900-1901.

Basel, Switzerland.—Naturforschende Gesellschaft: Verhandlungen, Vol. XIII: 1.

Berlin, Germany.—R. Friedländer & Sohn: Naturæ novitates, Vol. XXII, XXIII.

Béziers, France.—Société d' Etude des Sciences Naturelles: Bulletin, Vol. XXII.

Bombay, India.—Royal Asiatic Society: Journal, Vol. XX: 56.

Boston, Mass.—American Academy of Arts and Sciences: Proceedings, Vol. XXXVI.

Boston, Mass.—Horticultural Society: Transactions, 1900.

Brisbane, Queensland.—Royal Society of Queensland: Proceedings, Vol. XVI.

Bruxelles, Belgium.—Société Belge de Géologie: Bulletin, Vol. XIV.

Bruxelles, Belgium.—Société Malacologique de Belgique: Bulletin, 1900, 1901.

Bruxelles, Belgium.—Société Royal de Botanique de Belgique: Bulletin, Vol. XXXIX.

Buenos Aires, Argentine.—Instituto Geographico Argentino: Bulletin, Vol. XX: 7-12.

Buenos Aires, Argentine.—Museo Nacional: Com's. Vol. I: 7, 8.

Buenos Aires, Argentine.—Sociedad Cientifica Argentina: Anales, Vols. L, LI, LII.

Calcutta, India.—Geological Survey of India: Memoirs, Vols. II: 2; III: 1, 2; XXVIII: 2; XXX: 2; XXXIII: 1.

Cambridge, Mass.—Harvard College Observatory: Annals, Vols. XXXVII: 1; XXXVIII: 2; XLVIII: 7; Annual Report, 1900.

Cambridge, Mass.—Museum of Comparative Zoology: Bulletin, Vols. XXXVI: 7, 8; XXXVII: 3; XXXVIII: 2; XXXIX: 1.

Cape Town, South Africa.—South African Philosophical Society: Transactions, Vols. XI: 2; XII, pp. 1-563.

Cardiff, England.—Naturalists' Society: Report and Transactions, Vol. XXXII.

Catania, Italy.—Accademia Giœnia di Scienze Naturali: Bulletin, Nos. 64-70.

Chapel Hill, N. C.—Elisha Mitchell Scientific Society: Journal, Vol. XVII.

Cherbourg, France.—Société National des Sciences Naturelles: Memoirs, Vol. XXX, XXXI.

Chicago, Ill.—Botanical Gazette: Vols. XXXI, XXXII.

Chicago, Ill.—Field Columbian Museum: Publications, Nos. 45, 51-59.

Chicago, Ill.—John Crerar Library: Annual Report, Vol. VI.

Chicago, Ill.—Journal of Geology: Vol. ix.

Christiania, Norway.—Videnskabs Selskab: Skrifter, 1900.

Chur, Switzerland.—Naturforschende Gesellschaft Graubündens: Jahresbericht, Vols. xliii, xliv.

Colorado Springs, Col.—Colorado College: Studies, Vol. ix.

Columbia, Mo.—University of Missouri: University Studies, Vol. i: 1.

Denver, Col.—Colorado Scientific Society: Proceedings, Vols. vi; vii, pp. 13-40.

Des Moines, Iowa.—Geological Survey of Iowa: Annual Report, Vol. xi.

Des Moines, Iowa.—Iowa Academy of Sciences: Proceedings, Vols. vi, vii.

Emden, Germany.—Naturforschende Gesellschaft: Jahresbericht, Vol. lxxxv.

Firenze, Italy.—Biblioteca Nazionale Centrale: Bulletin, Nos. 357-360.

Frankfurt a d Oder, Germany.—Naturwissenschaftlicher Verein: Helios, Vol. xviii.

Fribourg, Switzerland.—Société Fribourgioise des Sciences Naturelles: Bulletin, Vol. viii; Memoirs, 1901.

Genève, Switzerland.—Société de Géographie: Le Globe, Vol. xl.

Georgetown, British Guiana.—Royal Agricultural and Commercial *Society*: Journal, Vol. xii.

Görlitz, Germany.—Naturforschende Gesellschaft: Abhandlungen, Vol. xxiii.

Graz, Austria.—Naturwissenschaftlicher Verein: Mitteilungen, Vol. xxxvii.

Guéret, France.—Société des Sciences Naturelles: Memoirs, 1900.

Guströw, Germany.—Verein der Freunde der Naturgeschichte: Archiv, Vols. liv: 2; lv: 1.

Halifax, Nova Scotia.—Nova Soctia Institute of Science: Proceedings, Vol. x: 2.

Hamilton, Canada.—Hamilton Association: Journal and Proceedings, No. 16.

Hannover, Germany.—Naturhistorische Gesellschaft: Jahresbericht, Vols. xlviii, xlix.

Harlem, Netherlands.—Musée Teyler. Archives, Vol. vii: 2, 3.

Hermannstadt, Austria.—Siebenbürgischer Verein für Naturwissenschaften: Verhandlungen, Vols. xlviii, xlix.

Innsbruck, Austria.—Naturwissenschaftenlich-Medizinischer Verein: Berichte, Vol. xxv.

Iowa City, Iowa.—Iowa Historical Society: Records, Vol. xvii.

Kassel, Germany.—Verein für Naturkunde: Abhandlungen, Vols. xliv, xlv.

Kiel, Germany.—Naturwissenschaftlicher Verein: Schriften, Vol. xii: 1.

Kjöbenhavn, Denmark.—Naturhistoriske Förening: Meddelelser, 1900.

Lansing, Mich.—State Agricultural College: Bulletin Exp. Station, Nos. 182-184, 186, 191.

Lausanne, Switzerland.—Société Vandoise des Sciences Naturelles: Bulletin, Vol. XXXVI.

Lawrence, Kans.—Kansas State University: Bulletin, Vols. I: 4-8; II: 1.

Liège, Belgium.—Société Géologique de Belique: Annales, Vols. XXVI, XXVII.

Liverpool, England.—Geological Society: Proceedings, Vols. VIII: 4; IX: 1.

Lüneberg, Germany.—Naturwissenschaftlicher Verein: Jahresheft, Vol. XV.

Madison, Wis.—Wisconsin Academy of Sciences, Arts and Letters: Transactions, Vol. XII.

Manchester, England.—Manchester Literary and Philosophical Society: Memoirs and Trans., Vol. XLV.

Mexico, Mexico.—Instituto Geologico Nacional: Bulletin, No. 14.

Milwaukee, Wis.—Public Museum: Annual Report, Vol. XVIII.

Montevideo, Uruguay.—Museo Nacional: Anales, Vols. II: 16, 17; III: 18, 20, 21.

Montgomery, Ala.—Geological Survey of Alabama: Plant-life of Alabama.

Montreal, Canada.—Canadian Record of Science: Vol. VIII: 5, 6.

Moskva, Russia.—Imp. Moscow Society of Naturalists: Bulletin, 1900: 1-3; 1899; 2-4.

New Haven, Ct.—Connecticut Academy of Arts and Sciences: Transactions, Vol. X.

New York, N. Y.—American Geographical Society: Bulletin, Vol. XXXIII.

New York, N. Y.—American Museum of Natural History: Bulletin, Vol. XIII.

Nürnberg, Germany.—Naturhistorische Gesellschaft: Abhandlungen, Vol. XIII.

Oberlin, Ohio.—Oberlin College: Library Bulletin, No. 5. Wilson Bulletin, Vol. VII.

Offenbach, Germany.—Verein für Naturkunde: Bericht, Vols. XXXVII-XLII.

Osnabrück, Germany.—Naturwissenschaftlicher Verein: Jahresbericht, 1899, 1900.

Ottawa, Canada.—Geological and Natural History Survey of Canada: Catalogue of Canadian Birds.

Pris, France.—Museum d' Histoire Naturelle: Bulletin, 1901.

Penzance, England.—Royal Geological Society of Cornwall: Transactions, Vol. XII: 6.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, Vol. LIII.

Philadelphia, Pa.—Wagner Free Institute of Science: Transactions, Vol. III: 5.

Philadelphia, Pa.—Zoological Society of Philadelphia: Annual Report, Vol. XXIX.

Port Louis, Mauritius.—Royal Alfred Observatory: Meteorological Observations, 1898.

Prag, Bohemia.—Böhmische Gesellschaft der Wissenschaften: Jahresbericht, 1899; Sitzungsberichte, 1899, 1900.

Reichenberg, Bohemia.—Verein der Naturfreunde: Mitteilungen, Vol. xxxi.

Riga, Russia.—Naturforscherverein: Korrespondenzblatt, Vols. xliii, xliv.

Rochester, N. Y.—Rochester Aacdemy of Natural Science: Proceedings, Vol. iv, pp. 1-64.

Rovereto, Austria.—Accademia degli Agiati in Rovereto: Atti, Vol. vi: 3, 4.

St. Gall, Switzerland.—Naturwissenschaftliche Gesellschaft: Bericht, 1899.

St. John's, New Brunswick.—Natural History Society: Bulletin, No. xix.

Saint-lô, France.—Société d' Agriculture et d' Histoire Naturelle de la Manche: Memoirs and Docum., Vol xviii.

St. Louis, Mo.—Missouri Botanical Garden: Annual Report, Vol. xii.

St. Louis, Mo.—St. Louis Academy of Science: Transactions, Vols. x: 8-11; xi: 1-6.

Sankt Peterburg, Russia.—Imp. Academy of Sciences: Bulletin, Vol. xii.

Sankt Petersburg, Russia.—Geological Committee: Bulletin, Vol. xix: 1-6; Memoirs, xiii: 3.

Sankt Peterburg, Russia.—Imp. Minerological Society: Verhandlungen, Vol xxxviii.

San Francisco, Cal.—California Academy of Sciences: Proceedings, Vols. i: 8, 9; ii: 4-11; iii: 1; Occasional Papers, Vol viii.

Santiago, Chile.—Société Scientifique du Chile: Actes, Vols. x: 2; xi: 1.

Sydney, New South Wales.—Australian Museum: Report, 1899; Records, Vol. iv: 1, 3, 4.

Sydney, New South Wales.—Geological Survey of New South Wales: Annual Report, 1899; Mineral Resources, No. 9.

Sydney, New South Wales.—Royal Society of New South Wales: Proceedings, Vol. xxxiv.

Stavanger, Norway.—Stavanger Museum: Aarsberetning, 1900.

Stockholm, Sweden.—Kongl. Svenska Vetenskaps-Akademien: Bihang, Vol. xxvi; Ofversigt, 1900.

Strassburg, Germany.—Geologische Landes-Untersuchung: Mitteilungen, Vol. v: 3.

Torino, Italy.—Museo Zoologico di Torino. Bulletin, Vol. xv.

Toronto, Canada.—Canadian Instituto: Proceedings, Vol. ii, 4; Transactions, Vol. vii: 1.

Upsala, Sweden.—Geological Institute University of Upsala: Bulletin, Vol. v: 1.

Urbana, Ill.—Illinois State Laboratory: Bulletin, Vol. v: 12.

Washington, D. C.—Bureau of American Ethnology: Annual Report, Vols. xvi, xvii.

Washington, D. C.—United States Geological Survey: Annual Report, Vol. xxi; Bulletin, Nos. 163-176.

Washington, D. C.—National Museum: Bulletin, Vols. xlvii: 4; l: 1; Proceedings, Vol. xxii.

Washington, D. C.—Patent Office: Official Gazette, Vols. xciv-xcvii.

Washington, D. C.—Smithsonian Institution: Annual Report, 1898.

Washington, D. C.—Weather Bureau: Monthly Weather Review, Vol. xxix; Report, 1899.

Wiesbaden, Germany.—Naturhistorischer Verein für Naturkunde: Jahrbuch, Vol. liii.

Winnipeg, Manitoba.—Manitoba Historical and Scientific Society: Annual Report, 1900; Transactions, Nos. 57-59.

Zurich, Switzerland.—Naturforschende Gesellschaft: Vierteljahrschrift, Vols. xlv: 3, 4; xlvi: 1, 2.

The following officers were elected:

President, - - - - - - - - - C. W. Hall.
Vice President, - - - - - - O. W. Oestlund.
Recording Secretary, - - - G. S. Beane.
Corresponding Secretary, - - C. P. Berkey.
Treasurer, - - - - - - - - - E. C. Gale.
Trustees, - - - - - - - - - H. T. Eddy.
E. C. Hale

President Hall then addressed the Academy on the Progress and Results of Scientific Research in Minnesota

257th Meeting, February 11, 1902.

Seven present.

Dr. J. K. Hosmer in the chair.

Program:

Studies in the Classification of Insects, by O. W. Oestlund.

Origin and Distribution of Minnesota Clays, by C. P. Berkey.

[ABSTRACT]

The paper presented was the result of the gathering of data on the clay industry of Minnesota, together with a review of the known geology of the state. The types of clays found and their occurrences were enumerated and the origin of each type outlined.

The classification made for Minnesota clays is:

1. Residuary Clays—
    - a.—From decay of feldspathic rocks,—unimportant.
    - b.—From residues of soluble rocks,—driftless area.
2. Transported Clays—
    - A.—Sedimentary Formations used as clays.
        - 1.—Argillaceous Slates:
            Huronian slates—unimportant.
        - 2.—Clay Shales:
            Ordovician shales—Southeastern Minnesota.
            Cretaceous shales—local.
    - B.—Glacial Clays:
        - 1.—Glacial till—very widely distributed.
        - 2.—Glacial Lake clays—many important deposits.
        - 3.—Glacial stream deposits—many occurrences along the Mississippi and Minnesota Rivers.
    - C.—Recent Alluvial Deposits.
    - D.—Loess or Wind Deposits,—the loam clays of Red River valley and other places.

The complete paper has been published in the American Geologist for March, 1902. Vol xxix, pp. 171-177.

Drs. Eddy and Hosmer were appointed a committee to be associated with A. D. Roe in the management of the museum.

The President and two Secretaries were appointed a membership committee.

258th Meeting, March 10, 1902.

Chemistry Lecture room, University of Minnesota.

President Hall presiding.

A good audience was present.

A paper on A Study of the Relation between Animal Structure and its Surroundings was read by Professor H. L. Osborn of Hamline University, and illustrated by charts and specimens.

259th Meeting, April 10, 1902.

Chemistry Lecture room, University of Minnesota.

President Hall in the chair.

Eighty persons present.

Dr. F. W. Sardeson gave an illustrated lecture on The History of Vertebrata from the Devonian age to Mamamalia and Man.

A communication from the Carnegie Institute of Chicago was read and referred to the Astronomical section with power to act.

260th Meeting, May 20, 1902.

Chemistry Lecture room, University of Minnesota.

President Hall in the chair.

A good audience present.

J. P. Magnusson of Brainerd, S. J. Race of Redwood Falls, C. W. Sage, of Fountain, and C. W. Jackson, of Hallock, were elected members.

Professor H. T. Eddy gave a lecture on Attenuation and Distortion of Long-Distance Telephone and Power Transmission Lines regarded as Hydrodynamic Phenomena.

[ABSTRACT.]

The analogy of a steady flow of water in a long pipe under the action of a constant head and a continuous current of electricity under a constant pressure such as is furnished by one or more cells of a battery, has often been employed to give a clear elementary physical conception of the mathematical relations expressed by Ohm's law. In this case the applied pressure is gradually consumed by the resistance experienced by the current, and in strict analogy with the flow of water, the loss per unit of length is proportional to the product of the square of the current and the first power of the resistance. So far as the mathematical relations are concerned the two problems are identical.

The object of this paper was to extend this hydrodynamic analogy to the more complicated case of long distance transmission of alternating currents in general.

Telephone transmission was specifically mentioned in the title in order to include the general case of variable frequency. The importance of thus extending and enlarging this analogy is evident when we reflect that all the complicated phenomena of long distance lines and cables with their sending and receiving apparatus may be completely reproduced in all its details of operation by simple pumping machinery with its transmission pipes and air chambers, whose manner of operation may be made clear to any one without the aid of higher analysis.

In conclusion, it may readily be shown that in both of the two extreme cases already considered, viz., those in which either friction or inertia is disregarded, the logarithm of the reciprocal of the amplitude, or intensity of wave at any point, varies directly as the product of the distance of the point from the source of the wave by its velocity. Since this velocity has already been shown to be constant in case the fluid friction may be disregarded and to increase with the frequency in case the inertia be disregarded, it is evident that the

attenuation depends upon frequency in case of fluid friction without inertia, but it is independent of frequency in case of inertia without fluid friction. Such unequal attenuation in the telephone obliterates to a greater or less extent tones of high pitch before it does those of lower pitch. It is therefore necessary to distinct transmission that the self induction of the line should be large enough to store a large amount of kinetic and potential energy in the wave motion along the line, which in all its aspects is strictly analogous to the wave motion propagated in the water in the apparatus just described.

261st Meeting, October 7, 1902.

Public Library; President Hall presiding.

Seven persons present.

A committee of Messrs Gale, Winchell, Eddy, and Hall was appointed to consider the property interests of the Academy.

F. C. Kent, H. L. Lyons, and F. K. Butters were elected members.

O. W. Oestlund read a paper on the Classification of Insects.

[ABSTRACT.]

A preliminary account was given on an extended work on the classification of insects. Attention was called to the value of some of the early writers on the taxonomy of insects as interpreted from a modern standpoint. Linné in his first edition of his *Sytema Naturae* divided the insects into three orders, (excepting the *Aptera*): 1. *Coleoptera*, including the Orthoptera. 2. *Hemiptera*. 3. *Angioptera*, indicating three main divisions of the class. In later editions Linné did not recognize the broad characters of the Angioptera. Latreille gave more exact interpretation to the same idea in his division of the orders in two main groups, the *Elytroptera* (including Orthoptera, Coleoptera, and Hemiptera), and *Gymnoptera*, equivalent to Linné's Angioptera.

It was pointed out that the so-called incomplete and complete metamorphosis has not the taxonomic value usually ascribed to it in dividing the insects into two series, the Heterometabola and the Holometabola. Metabolism is characteristic of the class and is undoubtedly monophyletic. The heterometabola are more primitive than the holometabola, but the holometabolous condition is polyphyletic, arising separately in several cases as in the Coleoptera, the males of the Coccidæ, and probably also for the Hymenoptera.

Paleontology also indicates some fundamental characters in the fact that the Paliodictyoptera contain three distinct lines of development: the Orthopteroidea, Hemipteroidea, and Neuropteroidea of Scudder. From the Orthopteroidea line of development we have the modern orders Orthoptera, and Coleoptera; the Hemipteroidea give us the Hemiptera and Homoptera; the Neuropteroidea have split up into the orders Neuroptera, Hymenoptera, Lepidoptera, and Diptera. Adopting Latreille's terms for the first and the third, and that of Fabricius for the second we have the three series Elytroptera, Rhynchota and Gymnoptera.

The three lines of modifications are also indicated by their habitat as one of the underlying causes. The Elytroptera are ground insects, hence their modification of the front wings for protection. The Rhynchota are semi-parasitic on plants, hence their main line of modification is seen in the formation of the jointed beak for piercing and sucking. The suctorial Hemiptera existed long before the suctorial trophi of the other orders had come into existence, and is a more primitive type than those of Diptera. The Gymnoptera are mainly arborial or aerial in habitat, the birds among the insects, hence their peculiar modifications of the wings so distinct from the first.

There are also some ontogenetic facts that point the same way. The embryonic membranes of primitive insects were temporary organs and did not persist to the time of hatching. Blastokenesis is characteristic of primitive Orthoptera, Hemiptera and Neuroptera. It is only in the more modern orders that one or both of the membranes persist to the time of hatching. Based upon these and other facts that await a future and more extended treatment, the following arrangement of the orders of insects into series was proposed.

Series *Elytroptera*. Ground insects; wings dissimilar, front pair elytra, hind pair membranous and folded when at rest, of primary importance in flight; trophi mandibulate. Orders:

Orthoptera, s. l.
Coleoptera.

Series *Rhynchota*. Semiparasitic; trophi forming a jointed rostrum adapted for piercing and sucking. The sucking trophi already present at the time of hatching. Wing modification of secondary importance in comparison with the Elytroptera, and Gymnoptera. Metamorphosis gradual. Orders:

Hemiptera.
Homoptera.

Series *Gymnoptera*. Arborial or aerial insects; the two pair of wings similar, the front pair of primary importance in flight; the hind pair often reduced or lost. Trophi mandibulate in Neuroptera; suctorial in the Hymenoptera, Lepidoptera, and Diptera. Orders:

Neuroptera, s. l.
Hymenoptera.
Lepidoptera.
Diptera.

The recognition of a larger number of orders, as the 17 of Brauer, or in a probable still greater division of the future, in no way invalidates the recognition of three series in place of two, but brings out a number of additional facts in its favor.

262d Meeting, January 5, 1903.

ANNUAL MEETING.

Secretary Berkey presiding.

Nine persons present.

The officers elected were:

President, - - - - - - - - T. B. Walker.
Vice President, - - - - - - C. P. Berkey.
Corresponding Secretary, - - - O. W. Oestlund.
Recording Secretary, - - - - Geo. S. Beane.
Treasurer, - - - - - - - - - Edw. C. Gale.
Trustees for three years, - - { A. D. Roe.
J. K. Hosmer.

Dr. A. H. Elftman read the outline of a paper prepared by him last year for presentation before the Geological Society of America on Moraines of Glacial Retreat across Minnesota.

263d Meeting, February 3, 1903.

President Walker in the chair.

Eight persons present.

The retiring Corresponding Secretary, C. P. Berkey, reported library accessions for the year 1902, as 393 foreign and 373 domestic publications, coming from 92 foreign and 60 domestic societies.

The total number of publications in the Academy Library to January 1, 1903, was 10,674:

Report of the Corresponding Secretary of accessions during 1902:

Agram, Hungary.—Jugoslavenska Akademija: Ljetopis, Vol. xvi; Rad, Nos. 147, 149.
Agricultural College, Mich.—Michigan Agricultural College: Bulletin Exp. Station, Nos. 193-202.
Albany, N. Y.—State Library: Annual Report, 1901.
State Museum: Annual Report, 1899; Bulletin, Nos. 48-57.
University of New York: Regents' Report, 1901.
Altenburg, Germany.—Naturforschende Gesellschaft: Mitteilungen, Vol. x.
Amiens, France.—Société Linnéenne du Nord de la France: Memoirs, Vol. x.

Baltimore, Md.—Johns Hopkins University: Circular, Nos. 155-160.

Barcelona, Spain.—Academia de Ciencias y Artes: Bulletin, Vol. II: 1-4; Memoirs, Vol. IV: 1-27; Nomina Personal, 1901.

Basel, Switzerland.—Naturfoschende Gesellschaft: Verhandlungen, Vols. XIII: 2, 3; XIV.

Belfast, Ireland.—Natural History and Philosophical Society: Report, 1900, 1901.

Berlin, Germany.—R. Friedländer & Sohn: Naturæ novitates, 1902.

Bombay, India.—Royal Asiatic Society: Journal, Vol XXI, No. 57.

Bône, Algeria.—Academie d' Hippone: Comptes Rendus, 1900.

Bonn, Germany.—Naturhistorische Verein: Verhandlungen, Vols. LVII: 1, 2; LVIII: 1; Sitzungsberichte, 1900, 1901.

Boston, Mass.—American Academy of Arts and Sciences: Proceedings, Vols. XXXVII; XXXVIII: 1-9.

Boston, Mass.—Boston Society of Natural History: Proceedings, Vol. XXX.

Boston, Mass.—Horticultural Society: Transactions, 1901.

Boulder, Col.—University of Colorado: Studies, Vol. I: 1, 2.

Bremen, Germany.—Naturwissenschaftlicher Verein: Abhandlungen, Vol. XVII: 1.

Brisbane, Queensland.—Geological Survey of Queensland: Publications, Nos. 127-178.

Brisbane, Queensland.—Royal Society of Queensland: Proceedings, Vol. XVII: 1.

Brünn, Austria.—Naturforschender Verein: Bericht, Vols. XVIII, XIX; Verhandlungen, Vols. XXXVIII, XXXIX.

Bruxelles, Belgium.—Société Malacologique de Belgique: Bulletin, 1902.

Budapest, Hungary.—Hungarian Central Bureau of Ornithology, Aquila, Vol. VIII.

Buenos Aires, Argentine.—Museo Nacional: Anales, Vols VII, VIII; Com's., Vol. I: 9, 10.

Buenos Aires, Argentine.—Sociedad Cientifica Argentina: Anales, Vols. LIII, LIV.

Calcutta, India.—Geological Survey of India: Memoirs, Vols. XXX: 3, 4; XXXI: 1-3; XXXII: 1, 2; XXXIII: 2; XXIV: 1.

Cambridge, Mass.—Harvard College Observatory: Annals, Vols. XLIV: 2; XLVII: 1; Annual Report, 1901.

Cambridge, Mass.—Museum of Comparative Zoology: Bulletin, Vols. XXXVIII: 3-5; XXXIX: 2-5; XL: 1-3; XLI: 1.

Cape Town, South Africa.—South African Philosophical Society: Transactions, Vol. XI: 3.

Cardiff, England.—Naturalists' Society: Report and Transactions, Vol. XXXIII.

Catania, Italy.—Accademia Gœnia di Scienze Naturali: Bulletin. Nos. 72, 73.

Cherbourg, France.—Société Nationale des Sciences Naturelles: Memoirs, Vol. XXXII.

Chicago, Ill.—Botanical Gazette, Vols XXXIII, XXXIV.

Chicago, Ill.—Field Columbian Museum: Publications, Nos. LX-LXVIII.

Chicago, Ill.—John Crerar Library: Annual Report, Vol. VII; List of Current Periodicals.

Chicago, Ill.—Journal of Geology, Vol. X.

Christiania, Norway.—Videnskabs Selskab: Förhandlingar, 1900, 1901; Skrifter, 1901.

Chur, Switzerland.—Naturforschende Gesellschaft Graubündens: Jahresbericht, Vol. XLV.

Cincinnati, Ohio.—Cincinnati Society of Natural History: Journal, Vol. XX: 1, 2.

College Hill, Mass.—Tufts College: College Studies, No. 7.

Columbia, Mo.—University of Missouri: University Studies, Vol. I: 2, 3.

Des Moines, Iowa.—Geological Survey of Iowa: Annual Report, Vol. XII.

Dorpat, Russia.—Naturforscher Gesellschaft bei der Universität: Archiv, Vol. XII: 1; Schrifter, No. 10; Sitzungsberichte, Vol. XII: 3.

Ekaterinburg, Russia.—Société Ouralienne des Amis des Sciences Naturelles: Bulletin, Vols. XXI, XXII.

Emden, Germany.—Naturforschende Gesellschaft: Jahresbericht, Vol. LXXXVI.

Firenze, Italy.—Biblioteca Nazionale Centrale: Bulletin, Nos. 1-22.

Frankfurt a d Oder.—Naturwissenschaftlicher Verein: Helios, Vol. XIX.

Fribourg, Switzerland.—Société Fribourgioise des Sciences Naturelles: Bulletin, Vol. IX; Memoirs, 1900.

Genève, Switzerland.—Société de Géographie: Le Globe, Vol. XLI.

Georgetown, British Guiana.—Royal Agricultural and Commercial Society: Journal, 1901.

Granville, Ohio.—Denison University. Bulletin, Vols. XI: 9-11; XII: 1-4.

Graz, Austria.—Naturwissenschaftlicher Verein: Mitteilungen, Vol. XXXVIII.

Guéret, France.—Société des Sciences Naturelles: Memoirs, Vol. VIII: 1.

Habana, Cuba.—Academia di Ciencias: Anales, Vol. XXXVIII.

Halifax, Nova Scotia.—Nova Scotia Institute of Science: Proceedings, Vol. X: 3.

Hamburg, Germany.—Verein für Naturwissenschaftliche Unterhaltung: Verhandlungen, Vol. XI.

Hamilton, Canada.—Hamilton Association: Journal and Proceedings, Vols. XVII, XVIII.

Harlem, Netherlands.—Musee Teyler: Archives, Vols. VII: 4; VIII: 1.

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Iowa City, Iowa.—Iowa Historical Society: Records, Vol. XVIII.

Kassel, Germany.—Verein für Naturkunde: Abhandlungen, Vols. XLVI, XLVII.

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Kief, Russia.—Kief Society of Naturalists: Memoirs, Vol. XVII.

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Krakowie, Austria.—Akademie der Wissenschaften: Rosprawy, Vols. XXXVIII, XL, XLI.

Lansing, Mich.—State Agricultural College: Bulletin Exp. Station, Nos. 193-198, 201.

Lausanne, Switzerland.—Société Vandoise des Sciences Naturelles: Bulletin, Vols. XXXVII, XXXVIII: 143, 144.

Lawrence, Kans.—Kansas State University: Bulletin, Vols. II: 2-9

Madison, Wis.—Wisconsin Geological and Natural History Survey: Bulletin, Vol. VII.

Manchester, England.—Manchester Literary and Philosophical Society: Memoirs and Proc., Vol. XLVI.

Mexico, Mexico.—Instituto Geologico Nacional: Bulletin, No. 15.

Milwaukee, Wis.—Public Museum: Annual Report, Vols. XIX, XX.

Montevideo, Uruguay.—Museo Nacional: Anales, Vol. III; 19, 22.

Montreal, Canada.—Canadian Record of Science: Vol. VIII: 7, 8.

Moskva, Russia.—Imp. Moscow Society of Naturalists: Bulletin, 1900: 4; 1901; 1902.

Nantes, France.—Société Académique de la Loire-Inferieure: Annales, Vols. I, II.

Neuchâtel, Switzerland.—Société des Sciences Naturelles: Bulletin, Vol. XXVII.

New York, N. Y.—American Geographical Society: Bulletin, Vol. XXXIV.

New York, N. Y.—American Museum of Natural History: Bulletin, Vols. XIV; XV: 1; XVII: 1, 2; XVIII: 1; Annual Report, 1900.

Nürnberg, Germany.—Naturhistorische Gesellschaft: Festschrift.

Oberlin, Ohio.—Oberlin College: Laboratory Bulletin, Nos. 11, 12; Wilson Bulletin, Vol. VIII.

Ottawa, Canada.—Geological and Natural History Survey of Canada: Annual Report, Vol. XI; Index to Reports, 1863-1884; Klondyke Goldfield; Report Meteorological Service, 1899, 1900.

Paris, France.—Museum d'Histoire Naturelle: Bulletin, 1902: 1-4.

Penzance, England.—Royal Geological Society of Cornwall: Transactions, Vol. XII: 7.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, Vol. LIV: 1, 2.

Philadelphia, Pa.—Zoological Society of Philadelphia: Annual Report, Vol. XXX.

Pisa, Italy.—Società Toscana di Scienze Naturali: Atti, Vol. XIII.

Portland, Maine.—Portland Society of Natural History: Proceedings, Vol. II: 5.

Port Louis, Mauritius.—Royal Alfred Observatory: Annual Report, 1899; Meteorological Observations, 1899.

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Riga, Russia.—Naturforscherverein: Korrespondenzblatt, Vol. XLV.

Rovereto, Austria.—Academia degli Agiati in Rivereto: Atti, Vols. VII: 1-4; VIII: 1, 2.

St. Gall, Switzerland.—Naturwissenschaftliche Gesellschaft: Bericht, 1900.

St. John's New Brunswick.—Natural History Society: Bulletin, Vol. XX.

St. Louis, Mo.—Missouri Botanical Garden: Annual Report, Vol. XIII.

St. Louis, Mo.—St. Louis Academy of Natural Science: Transactions, Vols. XI: 7-11; XII: 1-9.

Sankt Peterburg, Russia.—Imp. Academy of Sciences: Bulletin, Vols. XIII-XVII; Memoirs, Vols. X: 3, 5, 6, 7; XI: 5, 6, 7, 10, 11; XII: 4, 6, 7, 8; XIII: 3, 5, 7.

Sankt Peterburg, Russia.—Geological Committee: Bulletin, Vols. XIX: 7-10; XX: 1-6; Memoirs, Vol. XVIII: 1, 2.

Sankt Peterburg, Russia.—Imp. Minerological Society: Verhandlungen, Vol. XXXIX.

San Francisco, Cal.—California Academy of Sciences: Proceedings, Vol. III: 2-4.

Santiago, Chile.—Société Scientifique du Chile: Actes, Vol. XI: 3-5...

Sydney, New South Wales.—Australian Museum: Report, 1900, 1901; Records, Vol. IV: 2, 5, 6.

Sydney, New South Wales.—Geological Survey of New South Wales: Annual Report, 1901.

Stavanger, Norway.—Stavanger Museum: Aarsberetnig, 1901.

Stockholm, Sweden.—Geologiska Byron: Afhandlingar, A, 1902; Ba 6; C 184-192; Ca 1, 2.

Topeka, Kans.—Kansas Academy of Sciences: Transactions, Vol. XVII.

Torino, Italy.—Museo Zoologico di Torino: Bulletin, Vol. XVI.

Toulouse, France.—Académie des Sciences: Memoirs, Vol. I.

Washington, D. C.—Bureau of American Ethnology: Annual Report, Vols. XVIII, XIX.

Washington, D. C.—United States Geological Survey: Bulletin, Nos. 177-184, 187, 188, 190, 192-194, 199; Monographs, Vols. XXXIX, XL, XLI.

Washington, D. C.—National Museum: Bulletin, Nos. 39: N, P, Q; L: 2; Proceedings, Vol. XXIV.

Washington, D. C.—Patent Office: Official Gazette, Vols. XCVIII-CI; Annual Report.

Washington, D. C.—Smithsonian Institution: Annual Report, 1899.

Washington, D. C.—Weather Bureau: Monthly Weather Review, Vol. XXX: 1-10.

Wiesbaden, Germany.—Naturhistorischer Verein für Naturkunde: Jahrbuch, Vol. LIV.

Winnipeg, Manitoba.—Manitoba Historical and Scientific Society: Annual Report, 1901; Transactions, Nos. LX-LXII.

Zurich, Switzerland.—Naturforschende Gesellschaft: Vierteljahrschrift, Vols. XLVI: 3, 4; XLVII: 1, 2.

Zurich, Switzerland.—Physikalischen Gesellschaft: Jahresbericht, 1900. Mitteilungen, Nos. 1, 2.

American Association for the Advancement of Science: Proceedings, Vol. XLIX.

Australian Association for the Advancement of Science: Report, Vols. vii, viii.

A committee of T. B. Walker, N. H. Winchell, and C. P. Berkey was appointed to seek recognition and financial aid from the State Legislature.

264th Meeting, March 3, 1903.

Vice President C. P. Berkey in the chair.

Twenty persons present.

Program:

Some Minnesota Glacial Problems, by Dr. A. H. Elftman.

Review of the Question of the Age of the Fossil Man of Lansing, by Prof. N. H. Winchell.

265th Meeting, February 2, 1904.

ADJOURNED ANNUAL MEETING.

Secretary pro tem Roe presiding.

Reports of Treasurer E. C. Gale for 1902 and 1903 were read and approved.

Report of 1902:

Balance from 1901	$151.64	
Receipts from museum from April, 1901, to September 14, 1902	900.70	
		$1,052.34

Contra:

Cash paid Curator Roe for museum services April 1, 1901, to September 14, 1902	$698.95

To insurance for for three years	11.00	
" Fisher Paper Box Co.	5.55	
" University Press, printing	4.00	
" Franklin Printing Co.	3.00	
" cleaning museum	8.00	
" postal cards to G. S. Beane	1.75	
Balance on hand	320.09	
		$1,052.34

Report of 1903:

Balance from 1902	$320.09	
Contra:		
To Cor. Sec'y. Berkey for clerk hire and expenses	$ 26.25	
Jan. 30—To Rec. Sec'y. for printing and postage,	3.80	
May 28—To expenses on publications from Univ. of State of N. Y.	1.69	
May 30—To Rec. Sec'y. Beane for printing and postage	5.50	
Jan. 5, 1904—Cash on hand	282.85	
		$ 320.09

Report of the Corresponding Secretary of accessions for the year 1903:

Agram, Hungary.—Jugoslavenska Akademija: Ljetopis, Vol. XVII; Rad, No. 151.

Agricultural College, Mich.—Michigan Agricultural College: Bulletin, Nos. 204-210; Spec. Bulletin, No. 20.

Albany, N. Y.—State Library: Annual Report, 1902; Bulletin, No. 79.

State Museum: Annual Report, 1900; Bulletin, Nos. 267, 270, 271, 273, 274, 281-286, 288, 290, 291.

University of New York: Regents' Report, 1902.

Amsterdam, Netherlands.—Royal Academy of Sciences: Verhandlungen, Vol. VIII, Nos. 3-6.

Austin, Texas.—Texas Academy of Science: Transactions, Vol. V.

Baltimore, Md.—Johns Hopkins University: Circular, Nos. 162-165.

Barcelona, Spain.—Real Academia di Ciencias y Artes: Bulletin, Vol. II: 5; Memoirs, Vol. IV: 28-36; Nomina Personal, 1902.

Basel, Switzerland.—Naturforschende Gesellschaft: Verhandlungen, Vols. XV: 1; XVI.

Belfast, Ireland.—Natural History and Philosophical Society: Guide to Belfast.

Bergen, Norway.—Bergens Museum: Aarsberetning, 1899-1902; Aarbog, 1896-1902, 1903: 1.

Berlin, Germany.—R. Friedländer & Sohn: Naturæ Novitates, 1903.

Bologna, Italy.—Accademia delle Scienze dell' Instituto di Bologna: Memoirs, Vol. VIII; Rendiconto, Vol. IV.

Boston, Mass.—American Academy of Arts and Sciences: Proceedings, Vols. XXXVIII: 10-26, XXXIX: 1-12.

Boston, Mass.—Boston Society of Natural History: Proceedings, Vol. XXXI: 1-5.

Boston, Mass.—Horticultural Society: Transactions, 1902, 1903.

Boulder, Col.—University of Colorado: Bulletin, Vol. V: 4; Studies, Vol. I: 3; Dpt. Psychology, Vol. I: 3, 4.

Bremen, Germany.—Naturwissenschaftlicher Verein: Abhandlungen, Vol. XVII: 2.

Brisbane, Queensland.—Geological Survey of Queensland: Publications, Nos. 179-183. Sketch of Map of Queensland.

Brisbane, Queensland.—Royal Society of Queensland: Proceedings, Vol. XVII: 2.

Brooklyn, N. Y.—Institute of Arts and Sciences: Bulletin, Vol. I: 1-3; Cold Springs Monographs, Nos. 1, 2.

Brünn, Austria.—Naturforschender Verein: Bericht, Vol. XX; Verhandlungen, Vol. XL.

Bruxelles, Belgium.—Société Entomologique de Belgique: Annales, XLVI.

Budapest, Hungary.—Hungarian Central Bureau of Ornithology: Aquila, Vol. IX.

Buenos Aires, Argentine.—Museo Nacional: Annales, Vol. I: 2.

Buenos Aires, Argentine.—Sociedad Scientifica Argentina: Anales, Vols. LV; LVI: 1-3.

Calcutta, India.—Geological Survey of India: Report, 1900-1901; Memoirs, Vols. XXXII: 3; XXXIII: 3; XXXIV: 2; XXXV: 1.

Cambridge, Mass.—Harvard College Observatory: Report, 1903; Annals, Vols. XLVI: 2; XLVIII: 9; LIII: 3, 4; LVI: 1; Circulars, Nos. 74-75, 83-85.

Cambridge, Mass.—Museum of Comparative Zoology: Bulletin, Vols. XXXIX: 6-8; XL: 5-7.

Cape Town, South Africa.—South African Philosophical Society: Transactions, Vols. XII, pp. 561-920; XIV: 1, 2.

Catania, Italy.—Accademia Gioenia di Scienze Naturali: Bulletin, Nos. 74-78.

Chapel Hill, N. C.—Elisha Mitchell Scientific Society: Journal, Vols. XVIII, XIX.

Chatham, Canada.—Miramichi Natural History Association: Proceedings, No. 3.

Cherbourg, France.—Société Nationale des Sciences Naturelles: Memoirs, Vol. XXXIII: 1.

Chicago, Ill.—Botanical Gazette: Vols. XXXV, XXXVI.

Chicago, Ill.—Chicago Academy of Sciences: Bulletin Nos. 3: 2, 4, 5; Spec. Publication No. 1.

Chicago, Ill.—Field Columbian Museum: Publications, Nos. 69-74, 76, 79, 80.

Chicago, Ill.—John Crerar Library: Annual Report, Vol. viii; Suppl. to List of Serials.

Chicago, Ill.—Journal of Geology: Vol. xi.

Cincinnati, Ohio.—Cincinnati Society of Natural History: Journal, Vol. xx: 3.

Cincinnati, Ohio.—Lloyd Library of Botany: Bulletin, No. 6; Mycological Notes, Nos. 10-14.

Colorado Springs, Col.—Colorado College: Studies, Vol. x.

Columbia, Mo.—University of Missouri: University Studies, Vols. i: 5; ii: 1, 2.

Denver, Col.—Colorado Scientific Society: Proceedings, Vol. vii, pp. 55-138.

Des Moines, Iowa.—Iowa Academy of Sciences: Proceedings, Vols. viii-x.

Dorpat, Russia.—Naturforscher Gesellschaft bei der Universität: Archiv, Vol. xii: 2; Sitzungsberichte, Vol. xiii: 1; Schrifter, No. 11.

Fireze, Italy.—Biblioteca Nazionale Centrale: Bulletin, Nos. 24-35.

Frankfurt a d Oder, Germany.—Naturwissenschaftlicher Verein: Helios, Vol. xx.

Fribourg, Switzerland.—Société Fribourgeoise des Sciences Naturelles: Bulletin, No. 10; Memoirs, Geol. Vol. iii: 1; Chemie, Vol. ii: 1; Math. Vol. i: 1.

Genève, Switzerland.—Société de Géographie: Le Globe, Vol. xlii.

Georgetown, British Guiana.—Royal Agricultural and Commercial Society: Journal, 1902.

Glasgow, Scotland.—Natural History Society: Proceedings, Vols. v: 3; vi: 1-2.

Granville, Ohio.—Denison University: Bulletin, Vol. xii: 5-7.

Graz, Austria.—Naturwissenschaftlicher Verein: Mitteilungen, Vol. xxxix.

Griefswald, Germany.—Naturwissenschaftlicher Verein: Mitteilungen, Vols. xxxiii, xxxiv.

Groningen, Netherland.—Naturkundig Genootschap: Bijdrag, Vol. ii.

Halifax, Nova Scotia.—Nova Scotia Institute of Science: Proceedings, Vol. x: 4.

Harlem, Netherlands.—Musée Teyler: Archives, Vol. viii: 1-4.

Iowa City, Iowa.—Iowa Historical Society: Journal, Vol. i.

Iowa City, Iowa.—State University of Iowa: Bulletin, No. lxvii.

Kazan, Russia.—Society of Naturalists of the Imp. University: Memoirs, Vols. xxxv: 6; xxxvi: 1-6; Protokol, 1901-1902.

Kharkow, Russia.—Society of Naturalists of the Imp. University: Travaux, Vols. xxxvi, xxxvii.

Kief, Russia.—Kief Society of Naturalists: Memoirs, Vol. xvii: 2.

Kiel, Germany.—Naturwissenschaftlicher Verein: Schriften, Vol. xii: 2.

Kjöbenhavn, Denmark.—Naturhistoriske Förening: Meddeleser, 1903.

Krakowie, Austria.—Akademie der Wissenschaften: Rosprawy, Vol. XLII.

Lausanne, Switzerland.—Société Vandoise des Sciences Naturelles: Bulletin, Vols. XXXVIII: 145; XXXIX: 146.

Liège, Belgium.—Société Géologique de Belgique: Bulletin, Vol. XXIX.

Lincoln, Neb.—University of Nebraska: University Studies, Vols. II: 3, 4; III: 1-4.

Liverpool, England.—Geological Society: Proceedings, Vol. IX: 2, 3.

Llinas, Spain.—Observatorio Belloch: Meteorological Charts, 1902.

Madison, Wis.—Geological and Natural History Survey: Bulletin, Nos. 8-10.

Manchester, England.—Manchester Literary and Philosophical Society: Memoirs, Vol. XLVII.

Manila, Philippine Ids.—Museum of Natural History: Bull. Nos 1, 2.

Metz, Germany.—Société d' Histoire Naturelle: Bulletin, Vols. VI-X.

Mexico, Mexico.—Instituto Geologico Nacional: Bulletin, No. 16.

Milwaukee, Wis.—Natural History Society: Bulletin, Vol. II: 4.

Missoula, Mont.—University of Montana: Bulletin, Nos. 10, 17.

Montevideo, Uruguay.—Museo Nacional: Anales, Vol. IV, pp. 29-89, 123-152.

Montgomery, Ala.—Geological Survey of Alabama: Bulletin, No. 7.

Montreal, Canada.—Natural History Society: Record, Vol. IX: 1.

Moskva, Russia.—Imp. Moscow Society of Naturalists: Bulletin, 1903, 1.

Nantes, France.—Société Académique de la Loire-Inferieure: Annales, Vol. III.

New York, N. Y.—American Geographical Society: Bulletin, Vol. XXXV.

New York, N. Y.—Linnean Society: Abstracts, Vols. XIII, XIV.

Nürnberg, Germany.—Naturhistorische Gesellschaft: Jahresbericht, 1900, Verhandlungen, Vols. XIV, XV: 1.

Oberlin, Ohio.—Oberlin College: Wilson Bulletin, Vol. IX.

Osnabrück, Germany.—Naturwissenschaftlicher Verein: Jahresbericht, 1900; Verhandlungen, Vol. XV.

Ottawa, Canada.—Geological and Natural History Survey of Canada: Annual Report, Vol. XII; Catalogue of Canadian Birds, Part 2; Maps.

Paris, France.—Museum d' Histoire Naturelle: Bulletin, 1902; 518; 1903: 1, 2.

Penzance, England.—Royal Geological Society of Cornwall: Transactions, Vol. VIII.

Perth, West Australia.—Geological Survey of West Australia: Bulletin, No. 7, Maps.

Philadelphia, Pa.—Academy of Natural Sciences: Proceedings, Vols. LIV: 3; LV: 1, 2.

Philadelphia, Pa.—Wagner Free Institute of Science: Transactions, Vol. III: 6.

Philadelphia, Pa.—Zoological Society of Philadelphia: Annual Report, Vol. XXXI.

Pittsburg, Pa.—Carnegie Museum: Annals, Vol. I; Publications, Nos. 5-7, 8-10, 12, 15, 19, 20, 22; Memoirs, Vols. I; II: 1.

Prag, Bohemia.—Böhmische Gesellschaft der Wissenschaften: Jahresbericht, 1902.

Reichenberg, Bohemia.—Verein der Naturfreunde: Mitteilungen, Vols. XXXIII, XXXIV.

Riga, Russia.—Naturforscherverein: Korrespondenzblatt, Vol. XLVI.

Rochester, N. Y.—Rochester Academy of Natural Sciences: Proceedings, Vol. IV, pp. 65-88, 93-136.

Rovereto, Austria.—Accademia degli Agiati in Rovereto: Atti, Vol. VIII: 3, 4; IX: 1, 2.

St. Gall, Switzerland.—Naturwissenschaftlicher Gesellschaft: Bericht, 1901.

St. Louis, Mo.—Missouri Botanical Garden: Annual Report, Vol. XIV.

St. Louis, Mo.—St. Louis Academy of Science: Transactions, Vol. XIII. 1-4.

Sankt Peterburg, Russia.—Geological Committee: Bulletin, Vols. XX: 7-10; XXI: 1-4; Memoirs, Vols. XV: 4; XVII: 1, 2; XVIII: 3; XIX: 1; XX: 2.

Sankt Peterburg, Russia.—Imp. Minerological Society: Materialien, Vol. XXI: 1; Verhandlungen, Vol. XL: 1.

San Francisco, Cal.—California Academy of Sciences: Proceedings, Zool. 3: 5, 6.

Seattle, Wash.—Geological Survey: Annual Report, Vol. II.

Springfield, Mass.—Museum of Natural History: Report, 1902-1903.

Stavanger, Norway.—Stavanger Museum: Aarshefte, Vol. XIII, 1902.

Stockholm, Sweden.—Geologiska Byron: Afhandlingar, Ca No. 3; C 193, 194.

Stockholm, Sweden.—Kongl. Svenska Vetenskaps-Akademien: Bihang, Vols. XXVII, XXVIII; Archiv, Bot. 1: 1-3; Kemi 1: 1; Math. 1: 1, 2; Zool. 1: 1, 2; Arsbok, 1903.

Strassburg, Germany.—Geologischen Landes-Untersuchung: Mitteilungen, Vol. V: 4.

Sydney, New South Wales.—Royal Society of New South Wales: Journal, Vol. XXXV.

Thorn, Germany.—Copernicus Verein für Wissenschaft und Kunst: Katalog, 1903.

Topeka, Kans.—Kansas Academy of Sciences: Transactions, Vol. XVIII.

Torino, Italy.—Museo Zoologico di Torino: Bulletin, Vol. XVII.

Toronto, Canada.—Canadian Institute. Proceedings, Vol. II: 5; Transactions, Vol. VII: 2.

Toulouse, France.—Académie des Sciences: Memoirs, Vol. II.

Upsala, Sweden.—Geological Institute University of Upsala: Bulletin, Vol. V: 2.

Urbana, Ill.—Illinois State Laboratory: Bulletin, Vol. VI; Index to Vol V; Biennial Report, 1899- 1900.

Washington, D. C.—Bureau of American Ethnology: Bulletin, No. 27.

Washington, D. C.—United States Geological Survey: Annual Reports, Vols. XXII, XXIII; Bulletin, Nos. 205-207, 209-217; Monographs, Vols. xlii-xlv; Professional Papers, Nos. 1-10, 13-15; Water Supply, Nos. lxv-lxxxvi.

Washington, D. C.—National Museum: Bulletin, No. 52; Memoirs, Vol. viii: 5; Proceedings, Vol. xxv.

Washington, D. C.—Patent Office: Official Gazette, Vols. cii-cvi.

Washington, D. C.—Smithsonian Institution: Annual Report, 1901.

Washington, D. C.—Weather Bureau: Monthly Weather Review, Vols. xxx: 11, 12; xxxi: 1-9; Report of Chief, 1901-1902.

Wiesbaden, Germany.—Nuturhistorische Verein für Naturkunde: Jahrbuch, Vols. lv, lvi.

Winnipeg, Manitoba.—Manitoba Historical and Scientific Society: Annual Report, 1902; Transactions, No. 63.

Zurich, Switzerland.—Naturforschende Gesellschaft: Vierteljahrschrift, Vols. xlvii: 3, 4; xlviii: 1, 2.

Zurich, Switzerland.—Physikalischen Gesellschaft: Mitteilungen, Nos 3-5.

The foregoing report summarized shows 798 accessions from 143 societies and institutions.

The election of officers resulted as follows:

President, - - - - - - - - Professor C. W. Hall.
Vice President, - - - - - - Dr. A. H. Elftman.
Recording Secretary, - - - Harlow Gale.
Corresponding Secretary, - - O. W. Oestlund.
Treasurer, - - - - - - - - E. C. Gale.
Trustees for three years, - { N. H. Winchell. / Dr. T. S. Roberts.
Trustee for two years,
To succeed Dr. Hosmer - T. B. Walker.

Professor Hall then gave a resume of the papers and discussions on the Mississippi river in Section D, St. Louis meeting of the American Association for the Advancement of Science.

266th Meeting, March 8, 1904.

Psychological Laboratory of H. Gale, 812 S. 4th St.

Seven persons present.

President Hall in the chair.

The President announced that the Articles of Incorporation of the Academy were filed on March 31, 1876.

Professor John Zeleny read a paper on The Rate of Propagation of Smell.

[ABSTRACT.]

The speed with which smell is propagated through air was investigated for some substances by letting the smell pass through tubes where the disturbing influence of convection currents in the air is practically avoided.

It was found that the speed is quite small, showing that the rapid propagation ordinarily observed in free space is due almost entirely to convection currents. For example with ammonia diffusing through a glass tube 1.5 meters long and .76 cms. in diameter, over two hours elapsed before the smell could be detected at the other end of the tube. With different lengths of tubing it was found for ammonia and hydrogen sulphide that the time required for the diffusion of the smell was roughly proportional to the square of the length.

The presence of ammonia could be detected chemically at a given point in a tube in about the same time as when the sense of smell was used for a detector.

The rate of propogation of the smell of ammonia was not markedly different when this had to pass along the same tube either horizontally or vertically upward or vertically downward. With camphor, however, while the rates horizontally and vertically downward were about the same, the speed upward was about twice as great.

The smell given to brass and iron by rubbing them with the fingers was also tried but gave no definite results.

Professor O. W. Oestlund gave a review of recent entomological literature, speaking especially upon some papers by Marie V. Linden on pigments of Lepidoptera.

267th Meeting, April 11, 1904.

Geology Lecture room, University of Minnesota.

Thirty persons present; President Hall in the chair.

Pursuant to notice at last meeting the yearly dues of resident members were reduced from $3.00 to $1.00, the same as of non-resident members. The President explained that this does not affect the customary election fee of $5.00. Program: "The Gypsum Deposits of New York," by Mr. A. L. Parsons, being a preliminary report of his original studies under the Director of the N. Y. State Museum, illustrated with lantern slides and closing with an historical sketch of the process of manufacturing gypsum.

Wm. A. Bryan of the Bishop Museum, Honolulu, described this museum with the help of lantern slides. He then described his present work here in Pillsbury Hall, where he has been for some weeks examining the unmounted Menage collection of Philippine Islands birds, as part of his plan of working up the birds of Polynesia as he has already done those of the Hawaiian Islands. At the close of his talk he showed many of the birds in his workroom.

268th Meeting, May 11, 1904.

Geology Lecture room, University of Minnesota.

Eighteen persons present; President Hall in the chair.

Program: Preliminary report on Campodia Staphylinus, a primitive wingless insect, found for the first time in the West, by Prof. O. W. Oestlund. This insect was discovered by one of Prof. Oestlund's pupils, Kenneth Taylor, and was shown under the microscope. A few specimens of Scolpendrella Alanthia were found associated with it at the same time. Its bearings on Evolution were discussed by Dr. Sardeson, Prof. Washburn, and others.

Rise of Geographical Societies in America, by Pres. C. W. Hall. Copies of the geographical magazines were shown in illustration. The lately-formed Geographical Society of Minnesota, its objects and work, were then outlined.

269th Meeting, November 9, 1904.

President Hall's study, University of Minnesota, 4 P. M.

Five persons present.

President Hall read a letter from Miss Countryman, Librarian of the Public Library, about storing the museum cases until the room intended for the Academy on the second floor is finished. The former room of the museum has been assigned during the past year by the Library Board to the library. Miss Countryman also suggested a lease of the museum to the Library Board.

It was announced that a bulletin on the Menage Expedition was ready for printing.

Program: Dr. Sardeson reported the discovery in this vicinity of a coral Tetradium, and later he had found many of them in a quarry. They occur in the Galena Series.

H. Gale described Herbert Spencer's scientific method of work as described in his lately published autobiography.

270th Meeting, December 7, 1904.

Directors' room, Public Library.

President Hall presiding.

Program: "The Great Fault Line of Eastern Minnesota," by President C. W. Hall. The paper was illustrated by maps and profiles. Discussion by Prof. Winchell, Drs. Sardeson and Elftman.

"A Remarkable Glacial Plowing in Minneapolis," by Dr. F. W. Sardeson. This was followed by discussion.

271st Meeting, January 3, 1905.

ANNUAL MEETING.

Fifteen members and visitors present.

President Hall in the chair.

H. B. Norton was elected to membership.

Report of the Treasurer, E. C. Gale, showed he had handled $1,060.55 and had a balance on hand of $345.11; it was referred to the Trustees for auditing.

Corresponding Secretary Oestlund reported 381 accessions to the library during the year, and that a bulletin of the Academy would appear in about a month.

Accessions to the Library for the year 1904:

Adelaide, South Australia.—Royal Geograhical Society: Proceedings, Vols. VI and VII.

Agram, Hungary.—Jugoslavenska Akademija: Ljetopis, Vol. XVIII; Rad, Nos. 154, 155.

Agricultural College, Mich.—Michigan Agricultural College: Bulletin, Nos. 211-220; Special Bulletin, Nos. 24, 25, 27-29.

Albany, N. Y.—State Library: Annual Report, 1903; Bulletin, Nos. 84-86, 88.

State Museum: Annual Report, 1901; Bulletin, Nos. 63, 68-76.

University of N. Y.: Regents' report, 1903.

Baltimore, Md.—Johns Hopkins University: Circular, Nos. 2, 3, 5, 7, 8.

Barcelona, Spain.—Real Academia di Ciencias y Artes: Memoirs, Vols. IV, 37-40; V, 1. Nomina Personal, 1903.

Basel, Switzerland.—Naturforschende Gesellschaft: Verhandlungen, Vol. XV: 2.

Belfast, Ireland.—Natural History and Philosophical Society: Proceedings, 1902-1903.

Bergen, Norway.—Bergens Museum: Aarberetning, 1903; Aarbog, 1903, 2; 1904, 1.

Berkeley, Cal.—University of California: Publication, Vol. I, Nos. 2-4, 6, 7.

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Program: Some Geological Problems of the Black Hills, by Dr. A. H. Elftman.

Many charts and specimens of rocks and ores were exhibited in illustration of the paper.

The following officers were elected:

President, - - - - C. W. Hall.
Vice President, - - - Dr. A. H. Elftman.
Recording Secretary, - - Harlow Gale.
Corresponding Secretary, - O. W. Oestlund.
Treasurer, - - - - - Edw. C. Gale.
Trustees, for three years, - { H. T. Eddy.
E. C. Gale.

272d Meeting, February 6, 1905.

Thirteen members and visitors present.

President Hall in the chair.

Program: An informal talk on Recent Experiments with Homing Pigeons was given by Mr. Fred M. May, Secretary of the Minnesota section of the National Federation of Homing Pigeon Fanciers. Mr. May showed two of his homing pigeons, describing their training, races, records of speed, manner of starting and landing.

Deep wells as a source of water for Minneapolis, by Professor N. H. Winchell.

[ABSTRACT]

The author showed an outline map of the city on which were indicated the location and the depth of over sixty of the deep wells of the city, some of them being truly artesian. These included only those which are less than 450 ft. in depth, the deeper wells being excluded from the showing because of the greater mineralization of the water from the deeper strata. He stated that the water from the shallower wells is wholesome, clear, and has about the hardness of the water in the river, and hence is suitable for all domestic uses and for steam making. This source of water for city supply has been discredited because of the fact that numerous (perhaps the majority of) deep wells in the city are so deep that they derive their water from the lower strata, from 600 ft. to 800 ft., or 900 ft. below the surface. These waters incrust the boilers with a very troublesome scale and this scale sometimes has been known to choke the supply pipes. This trouble would be obviated or much reduced, by use of the shallower wells.

He also showed a map of the state on which were roughly expressed the limits of the water basins of the Jordan and the St. Peter sandstones which lie below Minneapolis and supply the shallower wells of the city. If one-tenth of their cubic contents may be assumed to be filled by water, the author stated that the gallons in the St. Peter basin amount to 4,054,110,793,200 and the water in the Jordan sandstone, about 400 ft. below the surface, amounts to 18,919,196,078,220 gallons. These subterranean basins are kept full by the streams and all surface drainage that cross their outcrop at points distant from the city at higher positions, including the Mississippi and nearly all its northern tributaries. The Mississippi itself is the surplus overflow and is less constant, as a source for the city, than the subterranean reservoirs. Water from these basins rises nearly to the surface throughout the city, and in low places it overflows in artesian style.

The author maintained that this source for city water should be used instead of an expensive plant for filtering the river water.

(This paper is incorporated in a more extended article on the

same subject published in the American Geologist for May, 1905, vol. xxxv, pp. 266-291.)

273d Meeting, March 7, 1905.

Twelve persons present; President Hall in the chair.

Program: An informal account, aided by charts and maps, of the work of the U. S. and Canadian Boundary Survey in the Rocky Mountains, was given by Mr. F. A. Camp, who was in charge of one of the survey parties in 1904.

Pres. Hall then showed a fine collection of photographs to illustrate the Geography and Geology of the Canadian Rockies. Much discussion.

274th Meeting, May 9, 1905.

Twenty present; President Hall presiding.

Program: Explorations of Verendrye and his sons, in connection with the History and Geography of Northern Minnesota, by Warren Upham, Secretary of the Minnesota Historical Society. (See paper K.)

An informal report was made by Harlow Gale of a Case of Multiple Personality by Dr. Albert Wilson in Vol. 18, pp. 352-418, of the Proceedings of the Society for Psychical Research. Some of the wider psychological bearings of the case were presented and discussed.

275th Meeting, October 10, 1905.

The four members present on this stormy night exchanged most pleasantly and profitably their experiences in summer scientific work and reading. Prof. Winchell showed two of his own photographs of the Willamette meteorite at the Lewis & Clark Exposition at Portland. This largest meteorite in the United States is 4 ft. in height through its cone shaps, 10 ft. in diameter in its base, and weighs towards 15 tons. The peculiar drill-like perforations about its base seem to be due to air friction, while the sponge-like structure of its bottom, which was towards the surface and not much covered, Prof. Winchell thought due to the decomposition of some other mineral substances in the iron.

Dr. Sardeson reported having found some specimens of Porocrinus, and in fact he had recognized a zone at various points about Minneapolis identical with that about Toronto and Baffin's Land, so that the same shore line had run through these three places.

Professor Arndt reported on his investigations into original methods of teaching science.

H. Gale reported on the interesting picture of scientific activity, mingled with a broad culture, found in the delightful "Briefe von Dr. Theo. Billroth."

276th Meeting, November, 1905.

Secretary's minutes lacking.

Paper L, Psychology of the Business Man by Harlow Gale.

277th Meeting, December 5, 1905.

Secretary's minutes lacking.

Paper M, Glacial and Modified Drift of the Mississippi Valley from Lake Itasca to Lake Pepin, by Warren Upham.

Paper N, Meteorological Statistics covering the period from 1895 to 1905 inclusive, furnished from the records kept at Minneapolis should have been announced at this meeting for publication.

[*Paper J.*]

A MINERAL RESEMBLING MEERSCHAUM FROM THE SERPENTINE RANGE OF HAMPDEN COUNTY, MASS., WITH DESCRIPTIONS OF INTERESTING INCLUDED CRYSTALS.

By A. D. Roe.

I.—DESCRIPTIVE.

While prospecting for cabinet specimens in the fruitful mineral field of Hampden and Hampshire counties, Mass., I noticed a substance which the chemist of the Hampden Paint company called meerschaum. On interviewing the chemist, I was shown small pieces found in the disintegrating serpentine material they were using in the manufacture of chrome paints.

On my next excursion to Chester in Hampden county, I accompanied Dr. Lucas, the inventor of the chrome paint process and promoter of emery mining in that region, to the exact locality of the paint material. Here I succeeded in unearthing good sized specimens of the so-called meerschaum. From one of these a friend, a meerschaum enthusiast, carved a pipe which polished, colored and was declared to exhibit the mythical properties of sepiolite. Subsequently I secured a lease of the locality and had an excavation made to the depth of a few feet, which satisfied me there was, at that point, no large nor continuous quantity of the substance in question, but I observed indications of the manner of its formation and obtained fine included specimens of rare and interesting minerals to be hereafter described.

This pseudo-meerschaum has a specific gravity of 2.5, is usually of a compact slaty structure, under a strong glass somewhat fibrous, cleaving in two directions, giving smooth, impalpable surfaces, creamy white in color, with a glimmering, waxy luster. It adheres slightly to the tongue, yields readily to the knife, at a hardness of 2.5; it could be easily turned in a lathe but for its slaty structure which causes it to split. (See plate vii, fig. vii.) It breaks with difficulty across its planes of cleavage with a very hackly fracture, but when polished gives the glimmering waxy luster of its cleavage faces. For this mineral I suggest the name hampdenite for reasons to be stated in another paragraph further on.

In composition the hampdenite and hampshirite are almost identical and closely approach some serpentines as is shown in the following table of analyses:

TABLE OF ANALYSES.

	1	2	3	4	5	6	7
SiO_2.....	45.78	42.09	42.83	39.38	42.54	38.60	44.1
Al_2O_3....	.65	.74	.61	1.56	3.78	0.10	
Fe_2O_3....					4.75		
						11.55	
FeO....	8.14	11.05	15.043	13.87	5.57		
MgO....	32.17	33.08	31.76	32.25	30.48	33.62	43.0
Na_2O....	.27	.31	.286				
K_2O.....	.081	.021	.053				
MnO....	1.21	1.78	1.08				
H_2O.....	11.44	10.01	7.16	11.90	13.13	12.82	12.9
Alkalies				.17		3.31	
	99.741	99.036	98.822	99.13	100.25	100.	100

1. Hampdenite, analyzed by E. E. Nicholson, the University of Minnesota.
2. Hampshirite, fibrous coating, E. E. Nicholson, the University of Minnesota.
3. Hampshirite, inside of crystal, E. E. Nicholson, the University of Minnesota.
4. Gray Serpentine, Brewsters, N. Y. Burt, Am. Jour. Sci., 1873, Vol, 6, p. 210.
5. Serpentine, chrysotile, Amelose, R. Brauns, Jahrbuch für Mineralogie, 1887; Beil., Bd. v, 299.
6. Serpentine, grass green, Porthalla, Collins, Quart. Jour. Geol. Soc. London, 1884, vol. 40, p. 467.
7. Serpentine, calculated, Dana, System of Mineralogy, 6th ed. p. 691, 1892.

Analyses 4 and 6 are quoted from Dana's System of Mineralogy, 6th edition, p. 672, and have not been further verified.

Noting the variation in silica and iron in the first three analyses Prof. Nicholson made a second and third determination of the iron with the result that the inside of the hampdenite which was less exposed to alteration yielded 10.24 percent of FeO which closely approaches No. 2, and the outer portion which was somewhat stained and leached yielded 8.07 percent of FeO. A second determination of the silica using the white material from the inside of the mass gave 42.78 per cent $Si\ O_2$ showing that the larger percentage of silica in No. 1 is probably due to alteration and loss of iron and magnesia. From these results it is evident that from the chemical analyses there would be no reason to make two separate varieties of these two substances, but the texture is so different that the author feels warranted in giving the name hampdenite to the massive splintery material as a distinct variety of serpentine while retaining the name hampshirite to indicate the serpentine pseudomorphs after humite.

The interior of the pseudomorphs is distinct from any serpentine that has come to the author's notice, being compact and massive, with an earthy feel and luster. The composition as determined by Prof. Nicholson is decidedly different from that obtained by Dewey* who obtained $Si\ O_2$ 50.60, Mg O 28.83, $Al_2\ O_3$ 0.15, FeO 2.59, MnO 1.10, H_2O 15.00 = 98.27, which would approximate more nearly the composition of sepiolite than of serpentine.

If the alumina and manganese be considered isomorphous with the iron and the potash and soda isomorphous with magnesia the composition for both hampdenite and hampshirite may be considered as $H_3\ Fe_4\ Mg_{21}\ Si_{18}\ O_{74}$ or 4 FeO, 21 MgO, 18 $Si\ O_2$, 15 $H_2\ O$, which would give a theoretic composition of approximately Fe O, 12; Mg O, 34; $Si\ O_2$, 43; H_2O, 11, which if we consider iron and magnesia to be isomorphous is not far from the theoretic composition of serpentine.

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*Am. Jour. Sci., 1822-1823, vol. 4, 275; vol. 5, 249, vol. 6, 334.

The mineral occurs at the foot of a steep, serpentine declivity in shaly, disintegrating rock, frequently in small masses or nests whose upper surface is convex with shallow smooth corrugations, so that its slaty cleavages sometimes show decided curvature.

In opening up the nests of pseudo-meerschaum or hampdenite, I brought to light a crystal of magnetite two inches across: it was a dodecahedron with striated faces modified by the truncation of half of its solid angles; it was symmetrical in form, having a small twinned attachment on one side. This specimen was transferred to Prof. Chas. U. Shepherd of Amherst College, and it was doubtless destroyed in the burning of his collection. Other similar crystals were obtained, measuring from three-fourths of an inch to over two inches—all modified dodecahedrons, (see plate vii, figs i and ii), but none so perfect as the first one found, most of them being attached to or imbedded in the coarse steatite or serpentine debris on which the nests of pseudo-meerschaum rested.

But a more interesting find than the magnetite was in the crystals believed to be pseudomorphic after humite from one to one and one-half inches in breadth, color brownish-yellow, texture loosely steatitic, hardness 1.5, specific gravity 2.23. They showed but one termination, the lower end being attached to the coarse mass below, as were the magnetite crystals.

These crystals recalled the brief notice of Dana regarding hampshirite as analyzed by Dewey and described in vols. iv, v, and vi, American Journal of Science (first series). This mineral was discovered by Dr. E. Emmons in the town of Middlefield, Hampshire county, Mass., and was named after the county in which it occurred. Professor Dewey visited the Emmons locality, described the crystals and the manner of their occurrence in an unnamed matrix, between heavy masses of serpentine. He declared they could not be pseudomorphs but were true crystals of steatite, and thought it would be difficult to get any more crystals from that locality. He found a few crystals of magnetite in the matrix with the hampshirite. Hermann later declared the crystals Dewey analyzed to be a distinct mineral.

Professor Dewey supposes the material between the masses of serpentine was deposited in a semi-fluid condition and that afterwards the crystals of iron oxide and hampshirite developed from elements distributed through the soft mass.

The same theory could be applied to the formation of the associated minerals I have described. Iron and chromium, in various combinations, are distributed through the magnesian rocks of the region. Disintegrating and decomposing agencies, constantly operating, cause the elements to mingle and develop new combinations.

The locality of these minerals is exactly on the line of Middlefield, Hampshire county, and Chester, Hampden county, beside the highway near where it crosses the Boston and Albany railroad. From this justaposition the name hampdenite seems appropriate to the pseudo-meerschaum which I have described as the matrix of hampshirite and magnetite, and the name hampshirite, the same as has been used by Emmons, Dewey and Herman, to the orthorhombic crystals described and figured in this paper, imbedded with large crystals of magnetite in the mineral, pseudo-meerschaum, herein named hampdenite.

The specimens of hampshirite have been examined by Mr. A. L. Parsons, instructor of mineralogy in the University of Minnesota, and their crystallographic characters are reported in paragraph II below.

II.—MORPHOLOGICAL, by A. L. Parsons.

The material is well adapted for securing measurements, though most of the faces are curved and pitted, particularly the pyramidal. It seems likely that the pseudomorph was formed by the loss of a part of the original material and hydration of that remaining. A list of the probable minerals from which it could be derived comprises enstatite, olivine, and the humite group.

Enstatite is dropped from consideration on account of the non-correspondence of angles. In the case of olivine, it is possible to get forms corresponding to the prismatic faces but the pyramidal faces would not correspond. The humite group exhibits a remarkable similarity of habit and its ordinary association with other minerals is so similar that there seems but little reason to doubt the original mineral was humite or possibly chondrodite. Aside from crystallographic grounds there is strong reason to expect pseudomorphous humite or chondrodite to occur in this locality and in such association, and equally good reasons why olivine should not yield such pseudomorphs. In the first place in the deposits of magnetite of southeastern New York at Brewster's and in Orange county, chondrodite, humite, and clinohumite are all found and at the Tilly Foster mine in particular all three occur with magnetite and an earthy serpentine or talcose material in addition to other constituents. In Massachusetts, chondrodite is found at Lee, and Tyringham.[*] It is also found "in the pre-Cambrian limestone at the mouth of Cole's Brook, at the railroad cutting west edge of large bed, in reddish and grayish grains changing into serpentine"[†] and from the description of this locality it is not more than a mile from the locality from which the material under discussion was obtained, and probably in the same formation. The determination of the Massachusetts mineral has however depended upon other than crystallographic means and as the mineral is granular in all the localities mentioned it is possible that in the western part of the state at least it is to be referred to humite. So far as can be learned, crystallized olivine in good-sized crystals has not been noted in Massachusetts, Connecticut, Vermont, or New York, but it has been found in New Hampshire though not in good crystals.

The angles on Mr. Roe's hampshirite are compared below with those of humite. (See pl. vii.)

TABLE OF CRYSTAL MEASUREMENTS

Angles	Hampshirite	Humite
o_2o_2 (210)	49°—50°	49° 40½′
ce_2 (001 014)	46° 30′—47°	45° 32⅓′
ce_3 (001 011)	74°	76° 13′
cl_2 (001 103)	55°[‡]	55° 44′
cr_3 (001 216)	58°	58° 16′

From these measurements it is seen that the crystal approaches one of the types found at Wermland in Sweden[*]

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[*] Dana, J. D., System of Mineralogy, 6th edition, 1892, p. 1059.

[†] Emerson, B. K., U. S. Geol. Sur. Bull. 126, 1895, p. 54.

[‡] Face not shown in figure.

[*] Sjogren, H., Zeits, fur Kryst. and Min., vii p. 344 et seq. and pl. vii. Also Hintze, C., Handbuch der Mineralogie, vii., p. 379, Fig. 147, 1897. Also Dana, System of Mineralogy, 6th edition, p. 535, 1892.

with the exception that the base (001) is lacking and the brachypinacoid e_4 (014) replaces the form e_2 (012) and the macropinacoid i_1 (101) is replaced by the form i_3 (103). (See plate vii, figs. iii, iv, v, and vi.)

Through the courtesy of Prof. B. K. Emerson, the material described and figured by him[†] has been at hand for comparison. (See plate vii, fig. vi.) In his description of the material it is to be noted that he orients his crystal in the same way as the present author, and although he mentions five forms he only gives two measurements, one of which appears to be correct and the other incorrect, on account of an imperfection in the crystal which would readily be overlooked without other material at hand for comparison. From a careful examination of Prof. Emerson's specimen, it appears almost impossible to secure measurements that will do more than give an approximation for any faces except the prism which he gives as ∞P (110) and the brachydome which he gives as $2\breve{P}\infty$ (021). In the case of prism my measurements agree with those of Prof. Emerson, but in the case of the brachydome, my measurements range from 92° to 95° while he gives the angle as ranging from 79° to 81° 30′. This discrepancy is due in all probability to the presence of a pseudo-cleavage in the fibrous coating of one of the crystals, as by measuring along this cleavage I secured approximately the same angle as Prof. Emerson.

By orienting the crystal so that 010 becomes 100 it is possible to get all the prismatic and normal faces to correspond to possible olivine forms but with two exceptions they have not yet been found on olivine crystals and it seems unreasonable to refer the source of this material to olivine when most of the faces do not correspond to known forms of olivine. These faces, do, however, closely approximate the forms of humite, the association is like that of humite, and if any other ground were necessary for discarding olivine as the source and substituting humite, it would be found in the size of the crystals which vary from about ¾″ to 2″ in length, the largest under investigation being the latter size, and the average about 1½″. Inasmuch as an olivine crystal two inches long is looked upon as of extraordinary magnitude, the presence of a large number of crystals of such great size in this locality, where no trace of olivine has been found, even by microscopic means, would at least seem to indicate some other source than olivine.

[†] Emerson, B. K., U. S. Geol. Sur. Bull. 126, 1895, p. 92, pl. 1, fig. 4.

III.—HISTORICAL NOTES.

The best specimen of hampshirite found in my explorations consisted of a group of crystals disclosed by cutting away the embedding hampdenite. When I came to Minnesota, this specimen was supposed to be packed for removal with a large collection previously on exhibition in a mineral store in New York City. On reaching my destination in Minnesota and unpacking my specimens, I missed the fine hampshirite and concluded the box containing it had been lost enroute. While revising this paper for publication my attention was called to the Mineralogical Lexicon of Franklin, Hampshire and Hampden counties, Massachusetts,* published by Prof. B. K. Emerson, of Amherst College. This lexicon contains notes on hampshirite which aroused my interest to that degree that I solicited of Professor Emerson the loan of the somewhat unique specimen belonging to the Clarke collection in Smith College. Through his courtesy that specimen was sent me for examination. (See plate vii, fig. vi.) Inspection proves that it is the identical specimen lost by me during my removal to Minnesota. The figure in Bulletin 126† gives a rough idea of the general appearance of this specimen, but fails to bring out fairly the unique appearance of the grouped hampshirite crystals. I took this specimen myself from an excavation in the locality above described; chipped away the embedding hampdenite from the rough block and exposed the crystals as they now appear upon the specimen. The labor devoted to this preparation as well as its peculiar formation gave an impression which leaves me no room to doubt the identity of this individual piece. I take great pleasure in inspecting this specimen and feel indebted to Professor Emerson for his courtesy in loaning it, thereby enabling me to identify beyond doubt my long lost crystal group, and thereby also enabling Professor Emerson to revise

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*Bulletin 126, U. S. Geol. Survey, Washington, 1895.
†Ibid, plate 1, Fig. D.

the unique label which appears in the Smith College collection.[*]

The hampshirite items appearing in Professor Emerson's lexicon[†] lead to the presumption that but few specimens of this mineral are extant, scarcely more in number than the distinct opinions as to its nature. In reviewing the literature, it seems that Professor Dewey declared the specimen true crystals of steatite, not a pseudomorph; President Hitchcock believed them to be steatite after quartz; Herman called them a distinct species; Professor Emerson speaks of them as serpentine crystals after olivine.[‡] To the foregoing opinions that of Mr. Parsons may be added declaring these crystals to be pseudomorphs after humite, an opinion which he supports by careful crystal measurements.

There is abundant opportunity in the great serpentine formations of Hampshire and Hampden counties to unearth more of the rare and interesting hampshirite. Since I have now pointed out the exact locality which was covered, not for the purpose of concealment, but because the excavation extended into the middle of a traveled highway, it is to be hoped that enthusiastic mineralogists will bring more of these rare crystals to light and Smith College may not be alone in the possession of this unique and interesting mineral.

January 3, 1899.

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[*] Hampshirite; steatitic pseudomorphs after quartz; Chester, Mass., on the road to Middlefield. Locality exhausted and filled up with rocks to prevent anything more being taken from it. Bailey thinks that this specimen could not be duplicated. From Row's collection; he procured it at the locality for $10.00.

[†] Ibid. pp. 91, 92, 152.

[‡] Bul. G. S. A., vol. vi. p. 473.

[*Paper K.*]

EXPLORATIONS OF VERENDRYE AND HIS SONS, FROM LAKE SUPERIOR TO THE ROCKY MOUNTAINS, 1728 TO 1749.

By Warren Upham.

My first interest in the life and work of Verendrye, the heroic first explorer of the northern border of Minnesota, came from my search for the origin, meaning, and earliest use of our Minnesota geographic names. In the year 1728, when Pierre Gautier Varennes, more commonly known by his title as the Sieur de la Verendrye, was stationed as an agent of the fur trade at lake Nipigon, north of lake Superior, a rudely sketched map was drawn for him by an intelligent Assiniboine Indian, named Ochagach, with aid by other Indians, tracing the canoe route of streams, lakes, and portages, from lake Superior along the north boundary of the present state of Minnesota to the Lake of the Woods, and thence northwestward to lake Winnipeg and the Saskatchewan river. This aboriginal delineation of geographic features northwest of lake Superior, with some names inserted by the French as derived from the Indians, was shown by Verendrye to Beauharnois, the governor of Canada, and about the year 1730 it was sent to France. The noted French geographer, Bellin, writing at Paris twenty-five years later, mentioned this sketch drawn by Ochagach for Verendrye as the earliest map of the country beyond lake Superior in the archives of the French Department of the Colonies. It remained unpublished, however, more than a hundred and fifty years, until a tracing of it was printed by Dr. Edward D. Neill, in 1882, in the fourth edition of his History of Minnesota. Two years afterward it was reprinted by Prof. N. H. Winchell in the first volume of his final report on the Geological and Natural History Survey of this state.

The series of many small lakes on our northern boundary is conspicuous on this map, and the thirteenth lake outlined, larger than any of the twelve others preceding it on the route going westward, is named Lac Sesakinaga, evidently the same as our present lake Saganaga. Rainy lake is called Lac Tecamamisuen; but the lake of the Woods and lake Winnipeg, though clearly identifiable by their delineation, the former having many islands, and the latter being narrowed at the middle, are unnamed. The Saskatchewan river, of which only the lower part is shown, not extending to the junction of its south and north branches, is called Fleuve de l' Ouest (River of the West.)

Not far south of the Saskatchewan, in the place of the Porcupine and Pasquia hills, the sketch of Ochagach bears the name Montagnes de pierres brillantes (Mountains of shining stones), which probably suggested later the names Shining mountains and Rocky mountains, applied to our great western Cordilleran belt. As known by Ochagach, however, and described by him to the French, the mountains of his sketch were doubtless the Cretaceous escarpment, generally from 500 to 1,000 feet in height of mostly steep ascent from its base to its top, south of the lower Saskatchewan and west of lakes Winnipegosis and Manitoba and the Red river. This escarpment is now known, in its successive parts from north to south, as the Pasquia and Porcupine hills, Duck mountain, and Pembina mountain, and the Coteau des Prairies, which reach from the Saskatchewan valley southward into North Dakota and to the southwest part of Minnesota.

The "shining stones" were probably selenite crystals from the Cretaceous shales, the same as those which Groseilliers and Radisson had seen, or of which they had heard some description, during their visit nearly seventy years before, in 1660, among the Prairie Sioux, in whose country, as Radisson wrote, "There are mountains covered with a kind of Stone that is transparent and tender, and like to that of Venice." The Sioux or Dakota people knew of the selenite crystals in the shales, and in the comparatively thin overlying glacial drift, which together form the Coteau des Prairies; and the Assiniboines knew of the same "shining stones" of the same formations in the Pembina, Riding, and Duck mountains, and in the Porcupine and Pasquia hills.

In 1731, Verendrye, commissioned and equipped by the Canadian government, with his sons and his nephew, Jemeraye, began their explorations far west of lake Superior, which they left by the route of Pigeon river and the series of lakes and streams continuing west along the present northern boundary of Minnesota. Fort St. Pierre, a trading post, was built at the mouth of Rainy lake; Fort St. Charles on the west side of the Lake of the Woods near its "Northwest Angle," and other forts or trading posts on lake Winnipeg and the Assiniboine and Saskatchewan rivers. Verendrye had more zeal for crossing the continent and reaching the Pacific than for the wealth to be gained by the fur trade. His expeditions did not financially meet expenses, and rivals sought to displace him from the patronage of the governor and the king; but shortly before his death, in 1749, when he had expected soon to set out again on new expeditions, the king honored him by the cross of St. Louis. The name of the St. Louis river, the largest tributary of lake Superior, probably came from this honor conferred on Verendrye. He was the founder of the fur trade in the northern part of Minnesota, in Manitoba, and the Saskatchewan region, where it greatly flourished during the next hundred years; and two of his sons were the first white men to see the Rocky mountains, or at least some eastern range of our great Cordilleran mountain belt.

The chief original sources of our knowledge of the explorations by Verendrye and his sons are the early French Colonial documents, of which a large number relating to their numerous exploring expeditions have been collected and published by Pierre Margry in the sixth volume of his "Discoveries and Settlements of the French in the West and in the South parts of North America, 1614-1754, Memoirs and Original Documents." In his last volume of the series, printed in French at Paris in 1886, pages 583-632 narrate the Verendrye explorations. The document which most interests us, as containing the narration of the journey in 1742-43 by two of Verendrye's sons to the Rocky mountains, is in pages 598-611, and is entitled "Journal of an Expedition made by the Chevalier de la Verendrye with one of his Brothers, for discovery of a passage to the Pacific Ocean; addressed to the Marquis de Beauharnois."

A very satisfactory manuscript discussion of the route of this expedition crossing the Plains from the Missouri river to the Rocky mountains, with platting of the courses as narrated, has been supplied to the Minnesota Historical Society from a corresponding member, Captain Edward L. Berthoud, of Golden, Colorado. This manuscript was received through the kindness of another member, Mr. Olin D. Wheeler, of St.

Paul, well known as the editor, for the Northern Pacific railway, of the yearly publication entitled "Wonderland," and author last year of an important historical work in two volumes, "The Trail of Lewis and Clark."

Captain Berthoud, following the narrative in the Margry Papers, shows that quite surely the Verendrye sons came, by southwest and south-southwest marching from the Mandans on the Missouri river to the Big Horn mountains. They first got a distant view of the mountains, as the Journal given by Margry tells us, on New Year's day of 1743. On January 21, in a great war party of the Indians of the Plains for attacking their hereditary enemies, the Shoshone or Snake Indians, at one of their great winter encampments, the Verendryes reached the foot of the mountains, which, as the Journal says, "are for the most part well wooded, and seem very high."

If they went, in this war raid, around or alongside the north end of the Big Horn range, they may have passed beyond the Big Horn river, coming to the Shoshone camp near the stream now known as the Shoshone river, tributary to the Big Horn river from the west, so that the mountains near whose base was the camp of the Snake Indians would be the Shoshone mountains, close southeast of the Yellowstone Park. Probably their extreme advance, to the Snake Indian camp, was somewhere in the foot-hills of the lofty and extended Big Horn range; and if they went beyond that range, I think that it was only to the Shoshone mountains.

The general route of the return was eastward to the Missouri river, as narrated in the Journal, and thence northward up the west side of the Missouri, to the Mandan villages, from which the expedition had started. This part of the journey is not considered in Captain Berthoud's manuscript. Both the outward march and the route of the return are well discussed by Parkman in his work of two volumes, "A Half Century of Conflict," published in 1892. Volume II, in pages 29-58, with a sketch map of the routes going to the Rocky mountains and returning east to the Missouri, as recorded in the Journal printed by Margry, gives a very vivid account of this whole expedition.

When the Verendryes reached the Missouri on the return, a cairn monument was erected by them on some hill or point of the bluffs overlooking that great stream, and a leaden plate, commemorating the expedition, was buried. This locality was somewhere near the present south boundary of South Dakota, about a months' travel below the Mandan villages. It would be a most interesting discovery, if this plate of lead, "bearing the arms and inscription of the king," could be found. Its burial was unknown to the Indians, who were merely told that the cairn was built as a memorial of the coming of these Frenchmen to their country.

It may well be hoped that some county yet to be formed on the northern border of Minnesota will receive the name Verendrye, in historic commemoration of the explorations, hardships, and sacrifices of the patriotic and truly noble Sieur de la Verendrye and his sons.

May 9, 1905.

[*Paper L.*]

THE PSYCHOLOGY OF THE BUSINESS MAN.

By Harlow Gale.

Having lived largely among business men for the past two years, after having been studying and teaching Psychology for eighteen years, it has been interesting to me to observe the mental life of the typical business man as he is specially different from the working man and professional man.

His eyes and ears, as the avenues of his connection with the world about him, are unusually acute and alert for everything connected with his business. He can size up the topography of a saleable piece of land, spy out new houses for insurance, hear an indistinct telephone order, or catch up customers' foreign names in a surprising way. The touch sense of the cloth and paper dealer is very sensitive; even the sense of taste and smell in the druggist and tea merchant is unusually acute. The special sense, then, which is of particular use in the life of each business specialist has been developed somewhat more than in the average man, just as the only remaining sense, that of touch, has been so remarkably developed in Helen Keller, Laura Bridgeman, and even in the merely blind.

Watch a business man rapidly going through a huge pile of correspondence, dictating letters in the midst of a noisy store or crowded office, reading his trade journal in the street car, or talking "business" on the street corner, and one sees a strong concentration of attention. The life insurance agent looks you straight in the eye and is not troubled with mind-wandering. The trader seizes the kernel of your proposition without being distracted by the blinding chaff. The drug buyer can turn from sulphur to patent medicines, from Christmas fancy goods to figuring complicated rebates, all with the greatest rapidity and no sign of confusion. Even in the midst of fatigue and sickness from overwork, it is often pathetic to see the business man's bulldog tenacity of attention.

Yet this astounding concentration of attention applies again, like the sense of acuteness, to each man's own business. The grain man's eyes wander and he yawns when he is talked to about violins or bricks; but mention chicken feed by chance and he wakes up. While I once enthused over the wonderful fall foliage of a grove of oaks on a vacant residence block of land, my companion, a real estate man, could only see and remark the burden of taxes as compared with the rising value of the unearned increment of the land and on passing his flat building which was being renovated and so much improved architecturally, that I could not help but compliment him on it, he could only reply by a long tale of his tribulations with his Union workmen. And, on my trying to suggest whether there were not some compensating advantages for co-operation in Trades Unions to offset his Union plumbers deserting him in the midst of a torn-up bathroom because they spied his janitor doing a little floor varnishing, he could not be brought to give these "theoretical" things any attention.

In remembering his own business matters, a man is also remarkable. Never can I forget the fun we used to have as young people with an apprenticed hardware clerk as we often called on him at social gatherings to reel off the long price lists of nails and glass, with their complicated discounts. He had of course never sat down and studied these lists; they had "just come to him in the store" by frequent use and by a pride he felt as a "promising young business man." The veteran old book store man can carry about more old editions and magazines in his head than the professional librarian. The life insurance solicitor hardly needs to refer not merely to his own book of rates but also to those of his competing companies and fraternal orders, nor does he forget the horde of solicited men who "don't need any insurance just now but may a little later." An old sewer foreman can give a new brick inspector a history of all the sewers he had built for the city during twenty-five years. The bank cashier carries in his responsible head a summary of business lives which far excels in detail the card catalogs of the mercantile agencies.

Thus what is useful to the business man he has precious little trouble in remembering. He needs no more coaching by patent memory systems to recall his necessary business details than to recognize his own stenographer or keep an appointment to sell a lot. The clan of Loisette trainers of "Memory" (as though it were a special muscle or rubber compartment instead of a complicated brain function attendant on all our sense perceptions and thought associations) have waxed strong by the despairing credulity of teachers, preachers, lawyers, and candidates for examinations who are forced to learn rules of mere words or gradgrind facts which fill no longing in their own or others' lives.

When it comes to doing things, the business man is a wonderful study in ideo-motor reaction or "Will," as such motor life was personified by the older psychologists. The idea of sluicing off a city mountain of dirt to tide flats for a great railway terminal no sooner comes into a vigorous Pacific coast man's head than he begins to do it, though it requires a long series of attempts at persuading the railway officials that the terminal can be made, the city officials that they should rent him the reserve water pumps, and the bank officials that they can risk him money for the venture. The idea of unusual profits in Kansas oil stimulated thousands of men to scrape together some money to put into the speculation. The idea comes to an insurance clerk to break away from his business master and set up for himself; he finds a little agency buys it with hardly money enough to pay his first month's rent, but he hustles about among his friends and makes a go of it. His friends are astonished at this sudden exhibition of "will power"; but this was his first really own idea, hitherto his ideas had been made by his family for him. The idea of putting his house rent into buying his own home occurs to a wholesale clerk with a growing family; he has to twist and turn by all kinds of plans to make some cash payment and see his way through the extra-sized rent payments, but he does it. This epochal family event gives him stimulus toward his idea of making himself so useful to his firm that they will give him some share in their stock,—all of which he in time accomplishes.

Because most plans of business men are quite complicated, involving many preliminary and side activities before the final compound end can be reached, a strong tenacity to the ultimate end is developed. Such a far-reaching persistence has also developed a complicated self-control. The business man is master of his muscles and expressions under sudden and new conditions. How far is this developed above the child with its primitive motor reaction of immediately grasping or wanting everything that attracts its attention!

When we observe how the business man gets the ideas and plans which he acts out, the first evident principle is imitation. Just as all follow the tailor's fashion plates and the changes in collars, hats and shoes, so the lowering and enlarging of show windows spreads up and down the retail streets. Just as the first bicycle or automobile is immediately lengthened out into a universal procession by all the live business men, so the advertising by one house furnishing firm of "Your credit is good at the Chip of the Old Block" is followed by all the other furnishing houses offering "Good Credit," "Your Own Terms," "We take care of our customers," &c., &c. The first cheap grade department store is followed by the enlarging of the old dry goods and carpet stores into selling everything from potatoes to pans, flowers and drugs. The magic spread of the typewriter, cash register and computing scales cannot be accounted for by their usefulness alone; many a small office or store is forced to go in prematurely for these machines "because the others do." The smoking, drinking, club and lodge habits, the winter flying trip to California or the South, the summer exodus to the mountains or the lakes, the shooting or trout fishing trip of the fall and spring and the occasional flight abroad are largely on the sheep-psychology principle of "follow the leader."

Some amusing examples of the conservatism of imitation, —for the one is largely founded on the other,—occurred to me with foreign tradesmen. Having evolved a pattern for a four-in-hand tie which was of certain unusual aesthetic proportions (for I was engaged, among other psychological experiments, in some on the mean-proportional relation in aesthetics) and was to be made so that, both ends and both sides could be used, I took this pattern and description to the best furnishing firm in Leipzig to get a dozen ties made up. After much consideration and perplexity the proprietor confessed that this was too new for his shop and that he would have to send the pattern over to England, from whence the ties finally came. Similarly at the shirt makers my plan for a small bosom shirt, that would be more comfortable and serviceable than a full sized bosom-board the whole length under one's vest, was met with the reply—"We never make them so." On my finally coaxing them to try and offering to pay extra for their trouble, the shirts were produced; but to my sample had been added a triangular piece over the opening between the shoulders. When I objected that I saw no utility in this addition to my design they only said—"We always make them so," and they could not think of removing the appendage until I insisted that I could remove it in a moment with their scissors. Likewise my English tailor insisted, tho to his loss and against my suggestion, in sewing by hand, as was his custom, rather than by machine the many yards of periphery around my long ulster and cape overcoat. Tho our American business men are by no means such blind followers of imitation, and tho there probably remains a relatively small circle of possible improvements in business methods as compared with the wonderful progress already made, yet imitation seems to be the overwhelming acting principle in each man's own business, just as it is the almost exclusive principle of his personal conduct.

The minority method of getting new ideas to put into practice is by reasoning. This is of course not always easy or sure to separate from imitation and there is probably a mingled zone of their mutual action between each's preponderating or exclusive field. But when a rental agent, e. g., who takes charge of an old house which has long sought in vain a tenant by simply exposing an imitation "For Rent" sign, freshens up the decrepit house front with a trifle of paint and a few shingles, he is not disappointed in his reasoning that this slight improvement will lead some house-seeker to the reasoned illusion that the whole house has been renovated or cared for. The fashionable city grocer reasons that he can hold the summer trade of his exodus host of customers to the neighboring summer resort by starting a branch store within their telephone and delivery limits. Of course his reasoned success is followed by many imitators, just as the success of the reasoned idea of attracting an enlarged public thru the mazes of a big department store by perching a dainty restaurant up across the furniture and china floor was followed by less original competitors. Is it possible now, among the hoard of imitators, to find the original reasoner who originated the brilliant advertising imposition of odd-figure prices, by which advantage is taken of the almost irresistible illusion that 99 cents is quite a ways off from a whole dollar and the inference that 32 cents must mean close figuring on profits, when the fact is that the 32 cent article could be bought at the old reliable store for an even quarter? The idea occurs to an old brick-teamster of making iron tongs which will pick up a good arm load of nine bricks, saving back, muscles, and time, in unloading bricks from a car to a wagon; reasoning out thus an artificial, large and sure hand as a betterment on the customary laborious and wasteful carrying or pitching of bricks from hands to hands. The imitator brick man, on seeing this "good scheme," and finding it not patented, naturally asks, in his reasoning, where the discoverer got them made and how much they cost. But if, on getting the tongs thus duplicated, the imitator reasons that tongs which seem to work effectively in unloading cars will be also effective in unloading from the wagon or loading from the kiln, such expectations will be disappointed.

The fresh college graduate, whose wealthy father has just died, is immediately approached with all sorts of business propositions on the reasoned expectation that he will be more easily influenced in favor of new schemes than the experienced paternal accumulator of his inherited money. The arguments for the visible typewriters and the distributed life insurance surplus are met by the counter arguments that an experienced typewriter or buyer of life insurance does not need or want to see his writing or the whereabouts of his surplus. The advantages of the exclusive wire telephone service is sought to be overcome by the cheaper cost of the community wire system. A veteran book seller surprises his street-gazing public by giving up his costly display window and moving his books to the unused sides of the much-traveled corridor of the latest big department store, because he reasons that his decreased sales to the mere passers-by will be more than compensated by his greatly decreased rent.

More entangled cases of business reasoning deal with estimates of character. A street railway manager described to me how he learned to "size up" applicants for positions by standing them up in a row, comparing the physiognomy of their heads, eyes, nose, and mouth; their standing posture and gait; their muscular vigor by a hand shake; and, if uncertainty yet remained, their voices, words and expressions in conversation. By scaling up and adding together these elementary signs of character in a way he could not further analyze or describe, he became quite expert in choosing men within the company's required variations of character. Yet he added that some remaining uncertainty and disappointment by this method of choosing employees was later helped by looking up the past working or business history of each applicant; for often more far-reaching inferences can be drawn from past actions to future actions than from the physiognomy signs of character. Likewise the bank cashier not merely becomes unconsciously a skilled reader of human character, but he wants to know the details of the borrower's plans and resources in order that he too may reason as to the promised repayment of the bank's money. And, if any doubt remains, the cashier's caution of their combined reasonings requires the name of an indorser whose financial reasoning and resources are willing to share the risk of the applied-for loan. In a similar way every petty tradesman or large wholesaler has to judge of the promised payments of his customers, leading to the caution against charging to strangers or too friendly friends, or entailing an expensive and most important department of "Credits." Thus the great mercantile agencies have developed out of the individual business man's reasoning as an organized and wide-reaching method of foretelling the probable means and expectations of the almost universal army of debtors. Think what an insignificant amount of business could be conducted if our credit civilization suddenly returned to the primitive cash or barter basis of exchange by eliminating the enormous and complicated business machinery built up on the reasoned-out expectations of future human actions from their past actions and character!

As to the two kinds of reasoning, induction and deduction, my observation and conviction is that the overwhelming part of the business man's, as well as all persons, serious, honest and useful reasoning is the carrying over from a more or less experienced association the belief that, when one member of the association again occurs, the other or a similar member has preceded or will follow. With the more or less conscious testing of this casual relation by the four casual tests of the methods of agreement, difference, concomitant variations and residues this makes up reasoning by induction, or from particular cases to a new case.

The little use that is made of deduction, or the referring a new case to a universal rule for its casual explanation seems to me chiefly in cases of illusion or imposition. Thus, the house-seeker in one of the above examples, was misled by his expectation that if some of the house was cared for all the house would be. The short-cut way of disposing of a foe or competitor by referring him to the Jews, Catholics or Democrats, as though they formed a universal sure premise of bad people, is, alas, very common. The implied reasoning in "it must be good if it comes from Brown's" is the suspicious major premise that "All Brown's things are good." The promising cheapness because of a "Fire Sale" or a "Remnant Sale;" reliable quality because of staid associations with the name Plymouth, New England, or Quaker, or style because from the Palace, Regal, or Imperial is the same sort of specious deductive reasoning with which a facetious passenger accosted the seated motorman of a powerless car.—"Why don't you go on? You're my friend, aren't you?"

On turning from the intellectual life of the business man to observe his emotional life or his pleasures and pains in the wide sense,—tho of course this is an artificial separation of what are actually intermingled,—the most striking characteristic is his pleasure in activity. While we all inherit, evolutionally, an instinctive pleasure in mere bodily activity (in common with the lower animals) from this feeling's being an advantageous incentive for us to be doing something, yet the business man has developed this instinct into an executive ability far more than the working or professional man. The laboring man has the natural pleasure in activity too much exercised and worn down by fatigue; the professional man has stunted his natural activity or developed it into more indirect and artificial forms; but the business man is a business man primarily because of his vigorous pleasure in doing things. The elastic step, cheery voice, and alert face of the hurrying business man on the street are contagious signs of his joyous pleasure in work. Even now a veteran business man occasionally still clings to the early farm hours of his youth, and is down at his winter or summer office before any of his clerks and takes a worthy pride in this early activity of the day.

Such a business hustler is restless and unhappy when still. A wealthy manufacturer was finally inveigled abroad with his whole family as a precaution for his health; but he no sooner got ashore at Alexandria, Athens, and Constantinople than he instantly got into cable communication with the price of wheat and sales of his flour. The trip did him no appreciable good; he was beamingly happy on getting back again to his haunted Chamber of Commerce, and died in the prime of life at full gallop in the business harness. Another wealthy man, who had built up a great firm, laughed at the idea of his lying still in a hospital bed a couple of weeks after an appendicitis operation; and, after reasoning and entreaties had been tried on him in vain, his angry threats of getting up from bed himself and going home in his own carriage were only met by the absolute commands of the doctor to his attendants.

On the other hand, even men with less than the average instinctive pleasure in activity can become entirely devoted to business thru the operation of custom or habit, which will develop pleasure in any kind of long-continued activity that is not positively killing in its operation. Thus many a restless wealthy merchant's son, whose pleasurable activity seems for some youthful years to be confined to sporting and society novelties, grows finally to be a concentrated business machine; for, as business habits engross him more and more, his family and friends are relieved at his settling down from a roaming life of search for excitement to the customary enslavement to office hours and desks, accomplished gradually by business habits. An instructive example of an extremely exclusive and artificial business criterion of happiness, tho highly idealized by Dicken's genial humor, has been given in Nicholas Nickleby's old clerk friend, Tim Linkinwater, who judges even the reported climate, flowers, and landscapes of the whole outside world, unknown to him, by the happy habit standards of his contented London office with its dark and barren prospect.

It sometimes happens, too, that a young lawyer, preacher or professor of college philosophy, whom chance or necessity has diverted from his original youthful ideals into some unexpected business scheme, becomes, through habit, so contracted in his business activity as to quite forget his "trailing clouds of glory." If he has time at all to look back from his pursuing and pursued real estate deals, it is to smile at his boyish illusions of helping the world,—"That was all very pretty; but I've had to get down to the business of pot-boiling, and that's now good enough for me."

Not seldom a pure example of mere business activity can be seen on the streets: as a whole-souled contractor who seems always hustling about on his wheel and yet is still the petty contractor of thirty years ago; or a business property owner, who has worn out a whole stable of horses and carriages in his enormous share of building up a western city, but has only a little country homestead left in which to end his worn-out days. Yet this fearfully strenuous business worker for everybody but himself is satisfied with his life's work, while his optimistic cheer thru all his business sunshine and shadows has been an untold blessing to his community

Allied to genius is the activity of the big-scheme man whose sole existence is the generation and execution of the original real estate auction, the first public park, a city market, glass works, a cemetery, or a fancy stock farm, a co-operation colony, etc., etc. His absorbing interest is in the discovery and initiation of the idea; while its execution he leaves, together with its business profits, if it finally has any, to smaller but more practical business parasites. Such business originality, with its disregard or neglect of its pecuniary advantages, is quite the opposite of the professional promoter of schemes whose executive energy and often unprincipled persuasive ability is solely bent on the gain. While the inventor's absorption in his ideas and their execution leads over from the business world into the art region of the creative architect, writer, poet and composer.

Along with the business man's pleasure in activity is usually associated, however, its companion pleasure of success; for it is not merely the doing, but also the succeeding, which is the aim and satisfaction of the business man. This pleasure in success is also an inherited mental instinct showing itself among the earliest mental signs of the child, having proved its serviceability in the long struggle for existence. For beyond the spontaneous activity of play there lies some goal which must be gained or the action is not successful. Imagine what a paralysis of the business world would happen if its workers suddenly lost the satisfaction of succeeding in their enterprises and merely did "busy work" like primary scholars in order to be kept occupied! A petty German harness dealer in an obscure street resisted a concert subscription with the reason that, having gained one business goal in the purchase of his own home and its adjacent lot, he was now aiming to take the special opportunity of buying his store building and lot. A veteran book-keeper, on the other hand, justified his taking a subscription by his satisfaction that his years of faithful service had at last succeeded in giving him the enjoyment of his highest needs. The son of an Irish school janitor shows a most commendable pride as he tips back in his present broker's chair and loves to recount how he has striven to be decent and respectable all thru his advancing stages of flour packer, proprietor of "241 Main St." (which he never calls a saloon), chattel mortgage loaner, flat owner, and timber land dealer. A hard working young corporation manager apologizes for his apparent luxury of a motor launch by the modest explanation that, having successively gained his business rewards of an unmortgaged home and country place, a safe life insurance provision for his large family, and one of the finest private libraries in his city, he can now reasonably begin to go in for some outward luxuries. When a reputed millionaire could not borrow a bank dollar in 1893, he proved himself a high Stoic philosopher in those straightened times by his satisfaction that at least he had accomplished something worth doing in his business evolution from a frontier store keeper thru a hardware merchant, lumberman, miller, governor, to a highly honored public benefactor. While in the uncertainties of life and billion dollar deals an irrepressible railway maker, who used to eat his tin pail dinner in the shadow of levee warehouses, pointed to his railway crossing half the map of America and said of this life's success,—"There, anyway, I've left a life mark that will stand."

Almost pure cases of the mental element of pleasure in success are seen, on the one hand, in the pitiful disappointment and shame, and in the premature ageing of an active business life, which finally encounters failure or bankruptcy. It is not the cessation of activity or the loss of the accumulated property, or the fear for the remaining necessities of life, which break the man; it is the pain of failure. On the other hand, there are the cases where the stress of business competition has so concentrated the worker's aim on success as to blind him to the living uses of the money he succeeds in getting. While the old fashioned miser, who secretly gains, hoards, and loves his gold for its own sake, is almost gone, his place has been taken a thousand fold by the modern competition—developed extreme business man who lives to win. He has developed the trust combinations and monopolies as means of beating by crushing out competition. The spirit of the modern extreme of business success is anything to beat, i. e., anything this side of a damaging public notoriety or the certainty of state's prison. The rational and normal business element of success, when it is so overwhelmingly present in the business mind, thus becomes irrational and pathological. Not that the beating-addicted hustler is always or largely planning and plotting to do up his competitors with deliberate and conscious malice. The rather does a vast deal of his mental perceptions and reasonings go on below the clear level of consciousness, down in the more or less dark regions of his subconsciousness. These considerable mental workings in so blind and mysterious a way,—which are being found to constitute a far larger part of all mental life than has ever been supposed,—all this extreme beatin-bind to the ways of genius again. Thus the "great captains of industry" are not usually by any means the frightful gorgons that they are often pictured, and ought even to be acquitted of much of the moral responsibility which is justly charged up against deliberate and conscious ill-doing to our fellow creatures. They are simply the extreme products of their strong heredity of activity and success, as developed in the beating environment of business competition.

Two more emotional traits are specially characteristic of the business man. One trait is his buoyant optimism. His belief that "it'll turn out all right" is almost unlimited. Even when his bank account is overdrawn and he does not know where the next dollar is coming from, he will give every street-greeter the confident assurance that his business is a "fine proposition." The pressure of the rent and collection agent cannot phase the shop keeper's confidence that he is all right any more than the lowering stock pointer or the losing gambling run can cool the better's confidence in his luck. And what is often so pathetic to observe is that, as a result of the business man's being rarely honestly content with his present stage of business, he exists largely by discounting his future "Great Expectations." A mighty business chorus never tires of stoutly singing—"There's a good time coming." While this optimism is sometimes merely a deceptive keeping up of appearances for the sake of credit or advertisement, it seems more often a genuine self-confidence and unconquerable belief in one's own city and country. The high bodily tension and vigorous health of the business man,—even if he does thereby run down and wear out a score of years earlier than he should,—is of course the physical basis of this undaunted optimism which is so powerfully infectious. What a picture of this American trait Dickens again has given in his jolly Mark Tapley during his business experience in the wilderness Utopia of Eden.

Along with this optimism is seen the other emotional trait of good nature. Just as the discouraged business man is quickly relegated to the care of his relations, so the recluse, unfriendly, or sour business man cannot exist under competition. Formerly, when the isolated shoemaker, tailor, or country store keeper had a monopoly of his district's trade, he could maintain some unpleasant personal idiosyncracies. But now the competition man of business has to fulfill the apostolic injunction,—"Be all things unto all men." Without the obsequiousness of the Europeans the American business man has a friendly face, cheerful greeting, and accommodating ways to all men. The book seller, insurance solicitor, or floor walker could no more be outwardly suspicious, critical, or even reserved than the cigar stand girl can afford to dress slovenly or not shake conversational dice with every customer.

This business advantage or even necessity for friendly good nature seems to have acted evolutionally towards the elimination from the business world of unpleasant dispositions; for, in spite of some artificial assumption of friendliness, the tendency is towards genuineness. The typical business man is a wholesome, gentlemanly, friendly, and cheery creature, who sheds a deal of courage, hope and sunshine thru the world. Much of this, too, he carries to the wife and children at home, except as it is counteracted by over-fatigue at the end of the day or by absorption of his interest and time in his business.

When we turn now to the lacking or harmful traits in the business mental life, the first striking characteristic is the monotony, uniformity and lack of individuality. The business forces and advantages, which conduce to a friendly good nature also tend to make all business men on the same pattern or mould. In having to be agreeable to everyone, the business man cannot seriously disagree or dispute, but the tendency is to accede and conform to others. Thus the Methodist or republican store keeper keeps these professions quiet when talking with his Catholic or democratic customer; the book seller and music teacher, who really like good books and music, have to talk and give trashy books and music to their society patrons. Even the bank cashier has to become almost an accomplished village barber in the catholicity of his conversational subjects. Just as the clothes and automobiles of the club men are hardly distinguishable from one another, so their conversation at the club lunch shows pitifully the lack of any mental individuality. In fact, to show any very decided or conspicuous mental characteristic, like an enthusiasm for chamber music, a devotion to Ibsen in the original, an aversion for club and society life, and critical distrust of religious revivals, is to make one's self peculiar, disliked, in bad form, and may perhaps harm one's credit. This uniformity is apparently not nearly so much a hiding of one's true traits as the lack of any strong feelings, convictions and interests outside his business, which go to make up a tame and unindividual personality.

And yet this illustrative case of business timidity happened to me. Wanting to have a brochure printed I warned my usual printer that some reflections in this paper on his great patron might harm him in the patron's eyes. But he assured me of his business independence and his belief in my paper until, on reading it for the first time in proof, he telephoned me with much shamefaced hesitation in his voice that he really did not know what he could do about that. Of course I relieved him from its embarrassment; he melted up the score of pages he had set up, and I took the copy, with the same warning, to another printer who had also had business relations with the same patron. Though this second printer was a fraternity brother with the first printer and both were college men, he was his business competitor and enemy, and said: "Why, of course, I can't touch this copy, though I believe it's all true; because if that damned C. got wind of it he would use it as a club against me with the N. But I tell you what, you take it down to the little Scandinavian job printer in the basement; he'll print the job in his name, but we'll do all the composition for him, you see?" I saw and did.

Then the natural childish instinct to deception for its advantage is (strongly cultivated by competition in the business man) up to the point of its being to his disadvantage. While the results in business methods of misrepresentation and adulteration are bad enough on the whole (although some valuable material progress is made against the conservatism of buyers by the surreptitious introduction of cheaper and harmless substitutes) yet the most pernicious form of business deception is in its tendency to superficiality of workmanship and of living. Just as our ready made clothes, shoes, and building are chiefly gotten up for cheapness and looks rather than for comfort and service, so the tendency of their designers and makers is towards inflating the appearance of their persons and business. Aided by his strong optimism and discounting of the future, by which he is always living on credit, this veneering of surfaces leads the business man to all the extravagant forms of living which make up the "grand game of bluff."

The show must be kept up at any cost. His "credit," that chaste maiden for whose honor he is so punctiliously chivalrous, must be guarded from every breath of suspicion. Each business man lives in the sight of his fellows and not for himself. Those who would naturally lead a simpler life are forced by their watered-stock business position, as an advertising proposition, or by the morbid social ambition of their wives and daughters, to set and keep up a scale of wasteful living that is often a nightmare to the whole family's souls. Think what a scaling down of stores, offices, houses, and turnouts, what a plucking of feathers and silks, what a breaking of plate glass and china there would be if every business man lived with his business and family on the safe side of his legitimate income!

Another unfortunate tendency of the competition business life is to dry up rather than cultivate the instinctive emotion of sympathy which otherwise naturally grows strong in the breezily optimistic western business man especially. But where his business forces him to look out, not for exchanging fair equivalents of labor, but to get the better of his customer as one means of beating his competitor in business,—under such conditions he naturally schools himself in the selfish principle—"let each look out for himself." So, tho he cannot afford to deny or dispute openly, he will quietly or indirectly let you drop or find a roundabout way to beat you. Even the many philanthropic and public enterprises, for which are long printed lists of business supporters, are forced to almost every kind of motive and argument except a pure sympathy for a good cause. The best argument for getting business guarantors and patron subscribers for a newly founded symphony orchestra was found to be that such a musical attraction had been demonstrated to bring to the city families of means who made good business for lot-sellers, house-renters, and trade in general. Even the good Y. M. C. A. is disgustingly habituated to appeal to its business public as a "paying proposition." Thus, while the occasional business man with some freedom from perpetual competition can use his leisure and natural altruistic sentiments in working disinterestedly for public benefactions, the typical trader's purse is only touched for public affairs by some motive for private gain.

Under such conditions, too, it is no wonder that the business man, who is hounded to death with an endless round of public and private appeals, develops a weary suspicion. While it is axiomatic with him that his business deals are for business and not for philanthropy, he naturaly becomes suspicious of the ingenious variety of philanthropical causes which masquerade about the streets under the pretense of business advantage, while of course against every legitimate business proposition he has to maintain, behind all the social forms of good nature, a guarded suspicion, until he can assuredly see his own advantage in the deal.

Finally, from a bird's eye position as a psychological observer, one comes to find that the combination of all the mental and bodily traits make together a splendid example of the law of mental causation, as against the old metaphysical doctrine of free will. For, the more one gets into view the mental components of the business man, the more one can see how his past conduct has been caused and how his future action will work out. Not but that he feels himself a free man; no one questions that. But that, in spite of this freedom from outward compulsion and his consciousness of doing "just as he wants to," his hereditary tendencies and acquired habits of feeling, thinking and acting give us a more complete casual analysis of his past life and a provision into his future. So that our residuum of uncertainty as to what he will want and "will" to do, which residum further lessons with our more intimate knowledge of each man, is far more reasonably charged up to our remaining ignorance of some of his mental components than to a separate and different kernel of metaphysical "Free Will." To be sure, even the business man's restricted round of life is the resultant of a conflicting lot of hereditary and environment components focusing into one body and head. But he must nevertheless be classed at the top of other complicated products of nature and art, as a human machine, and as a machine that has been developed evolutionally into wonderful efficiency for the environment in which he exists. May the future changes in his business environment give less necessity for his fighting nature and better play for his nobler self!

Summary:

1. The business man's intellectual life thru his sense perceptions, attention, memory, imitation, and reasoning, is unusually keen and efficient as far as concerns his business; much more than the over-worked and slower working man and probably more efficient than the pro-

fessional man with his over-developed and largely distorted intellectual development. His intellectual originality seems chiefly confined to methods of his own business, as they are improved thru largely subconscious inductive reasoning, what little deductive reasoning is used being largely for deception and imposition; while the greater part of his own business and most of his ideas outside his own business are gotten thru imitation.

2. His executive ability in carrying out his ideas places him away above all other men in the strength of his ideo-motor life of action. The working man's activity is more exclusively muscular, stimulated by bodily necessities or by example, i. e., is more sensory-motor activity; while the professional man's ideo-motor activity is largely stunted or works itself out more indirectly thru words. But the business man forms the middle class between these two extremes, primarily because of his strong and absorbing activity in doing things.
3. His emotional life chiefly centers in the pleasures of activity and success, which tend to be developed in his business to a morbidly absorbing passion of beating in a fight. His pleasure in established habit and custom makes him fundamentally conservative, which conflicts with the opposite pleasure of novelty only in the venturesome reasoned-out innovations or speculations of his business and in the restless chasing after any new excitement outside of business hours; for, as he has little permanent interest or pleasure in anything outside his business, his extra-business life is the childish or dissipating pleasures in the distractions of novelty. His living in the eyes of others and on credit make him a slave to a wearing tension of fashion and extravagance. As he lacks in sympathy and trust in others, so he decidedly excels all other men in an almost unconquerable optimism and a cheery good nature.

In all his emotional life, then, the business man differs from the working man chiefly in a stronger intensity rather than a larger range of emotions, just as, on the other hand, he is inferior to the professional man in his wider variety of intellectual and aesthetic pleasures.

4. He is a splendid example of mental causation, as against metaphysical Free Will, and, for his business functions, a marvelously efficient bodily and mental human machine.
5. His better mental traits of activity, success, some sympathy, and a deal of optimistic good cheer are his more natural characteristics by instinct, except that the optimism and good nature are increased by business life; while his lower traits of an exhausting high-pressure activity, absorption in beating, selfishness, suspicion, and a narrowness of intellectual and aesthetic interests, are chiefly developed by the competition struggle of business life.

November, 1905.

[*Paper M.*]

GLACIAL AND MODIFIED DRIFT OF THE MISSISSIPPI VALLEY FROM LAKE ITASCA TO LAKE PEPIN.

By Warren Upham.

From its source in lake Itasca to Minneapolis and St. Paul, the Mississippi river traverses a large area of the late glacial drift, with many marginal moraines, belonging to the Wisconsin stage of the Ice age. In the outermost moraine belt, intersected by this river within a few miles south of St. Paul, several moraines are merged together, namely, the Altamont, Gary, Antelope, Kiester, and Elysian moraines, or the first to the fifth in the series of twelve which are traced in well defined separate courses across the west half of Minnesota. Continuing eastward through the central and eastern parts of this state, these twelve moraines have an equally conspicuous development, in belts of irregularly knolly and hilly drift, partly till and partly modified drift, rising usually to heights of 50 to 150 feet above the smoother intervening drift tracts; but two or more consecutive moraines are in many places pushed together in the vicinity of the Mississippi river and farther east, or are interlocked as a network, so that the series mapped there can only be provisionally identified with the twelve distinct and successive moraines mapped west and north of this part of the Mississippi.

Above the junction of the Minnesota river, the upper Mississippi passes through six moraines formed later than those noted as confluent close south and east of St. Paul, these of later dates being the Waconia, Dovre, Fergus Falls, Leaf Hills, Itasca, and Mesabi moraines, which in this order are the sixth to the eleventh of the Minnesota series. Only one, the last and most northern recognized in the state, named the Vermilion or twelfth moraine, runs through northern Minnesota beyond the Mississippi watershed.

Details of the course, topographic features, material and structure, and the chronologic sequence, of these most prominent drift deposits of our region, have been published throughout the many chapters describing our counties in the final reports of the Minnesota geological survey. Little attention was given there, however, to the very interesting question of the probable length of time, in years and centuries or in thousands of years, occupied by the accumulation of this numerous series of frontal moraines, marking short or long pauses, or sometimes re-advances, of the ice border during its general wane and departure from the state area.

But in another work, for the United States Geological Survey, on the Glacial Lake Agassiz, I have shown reasons for ascribing to the entire history of that vast ice-dammed lake, stretching gradually about seven hundred miles from south to north in the valley of the Red river and the basin of lake Winnipeg, no longer time than one thousand years. This is a proportional estimate, in connection with the evidence set forth by N. H. Winchell, G. F. Wright, and other glacialists, both in America and Europe, including the present writer, that the Postglacial period, since the recession of the ice-sheets from the northern United States and Canada and from northwestern Europe, measures about 10,000 to 5,000 years, being approximately alike on opposite sides of the Atlantic.

In comparison with these estimates, the time required for the formation of any one of our great marginal moraines could be no more than a few decades. All the retreat of the ice-sheet on the moraine-bearing region of Minnesota, from the compound belt of marginal drift hills adjoining St. Paul to the Itasca, Mesabi and Vermilion moraines, at and beyond the most northern sources of the Mississippi, did not probably occupy more than ten or fifteen centuries. If the recession of a Mississippi cataract from the site of Fort Snelling northward, now called the Falls of St. Anthony, began only about 8,000 years ago, as shown by Winchell, the latest melting of the icefields on our northern boundary took place within some one thousand or fifteen hundred years afterward, that is, between 7,000 and 6,000 years ago.

Far greater age, however, must be attributed to the glacial drift of a tract 40 to 50 miles wide in southeastern Minnesota, lying next east of the outer moraines, which run southerly from St. Paul through the west part of Dakota county, and through Rice, Steele, and Freeborn counties, into Iowa. The tract of more ancient drift comprises much or all of Dakota, Goodhue, Wabasha, Dodge, Olmsted, Mower, and Fillmore counties, lying between the Altamont or first moraine and a large driftless area, which includes a width of 20 to 40 miles in the southeast edge of this state from lake Pepin southward, between the attenuated margin of the glacial drift and the Mississippi river. The same remarkable driftless area reaches thence nearly 100 miles east in Wisconsin, but has its greatest extent of about 150 miles from north to south, continuing, mainly east of the Mississippi, to the northwest corner of Illinois.

In the series of stages or epochs of the glacial period, characterized by alternating growth and wane of the continental ice-sheet, with advance, retreat and re-advance of its borders, ascertained by Chamberlin, Salisbury, Leverett, Calvin, and others, our tract of the old drift outside the moraines in the southeast part of Minnesota belongs probably to the Kansan stage of glaciation, when the ice-sheet attained its greatest extension in the center of the continent, probably fifteen or twenty times as long ago as the final departure of the ice from this state.

The great age of this drift is indicated in Dakota and Goodhue counties, bordering the Mississippi from St. Paul to lake Pepin, by occasional columnar or towerlike remnants of the St. Peter sandstone, of which the most noteworthy are Castle rock, about a mile east of the railway station of that name and Chimney rock, in the east edge of the northeast quarter of section 31, Marshan, about eight miles south of

Hastings. Castle rock originally had a height of 70 feet above the lowest ground at its base, and its upper 20 feet was a slender rock column, which, by the effect of subaerial erosion of its lower part, fell down several years ago. The Chimney rock here mentioned, one of several in Dakota county bearing this name, is the most picturesque and perfect example of columnar rock weathering in Minnesota, or indeed, as I believe, in our entire country. It is a vertical pillar, measuring 34 feet in height and about 6 and twelve feet in its less and greater diameters, being no thicker near the base than in its upper part. Plate VIII gives a view of this sandstone column, of which no former description or illustration has been published.

Such spires of easily crumbling sandstone could not endure the envelopment of this area by the slowly moving ice-sheet, which is known to have once existed there by the continuation of the very old drift many miles beyond these rock pillars. During the deposition of that glacial drift, knolls or small plateaus of the sandstone, capped by an exceptionally hard layer or by the next higher Trenton limestone, and having sufficient area to withstand the pressure of the ice current, doubtless occupied the sites of the Castle and Chimney rocks; and by subsequent erosion of weathering, through the agencies of rain and wind, cold and heat, the sandstone slowly crumbled away, leaving only these columnar masses. How long a time would be required for this result, we can only vaguely conjecture; but it seems probable that the 50,000 or 100,000 years which have been variously computed to have passed since the culmination of North American glaciation, in the Kansas stage, would suffice. It is evident that the relatively short time since the Illinoian and Iowan stages of glaciation would be inadequate.

The Ice age thus was very long in comparison with the Postglacial period. Indeed, the whole Quaternary era may have measured 150,000 years, or more, in which time were comprised the gradual oncoming of the ice-sheet, its repeated fluctuations, and at last its most energetic accumulation of marginal morainic hills, whenever its final melting and retreat were temporarily interrupted.

With the departure of the ice-sheet, while it was being melted back from one marginal moraine to another, yielding its ground in general by a recession from south to north, the

Mississippi valley was partly filled with modified drift, or the stratified gravel, sand, and fine silt, which form terraces or plains on either side of the river. An abundant supply of water from the dissolving ice and from rains caused the river to be in a continual flood stage during the summers; and much of the drift was then carried into the valleys of the great river and its tributaries, filling them from side to side up to the levels of their highest gravel and sand terraces. In proportion as the ice-sheet withdrew from this area, the tribute of drift borne into the valleys was greatly diminished, while yet the Minnesota and St. Croix rivers, and the Mississippi below their mouths, were flooded through every summer by the outflow of lake Agassiz and of the Western Superior glacial lake, both held by the barrier of the retreating ice-sheet farther north. Then the valley floodplains so lately formed were deeply channeled until the Mississippi flowed at levels 50 to 100 feet lower than now along some parts of its course in and adjoining Minnesota.

After the great discharge of the glacial lakes ceased, the ability of these rivers to erode their valleys was less, and in consequence the alluvium of tributaries has in some cases partly refilled the main valley. Thus the silt brought to the Mississippi by the Chippewa river during the Postglacial period has been spread as a barrier at its mouth and southward, forming lake Pepin, 25 miles long and 1 to 3 miles wide, which has a maximum depth of 56 feet in its southern part. The Mississippi valley for many miles below the lake has been refilled with the Chippewa alluvium nearly to that depth. In the same way lake St. Croix, 25 feet deep, has been formed in the St. Croix valley just above its mouth, by the barrier of the Mississippi alluvium; and likewise the shallower Lac qui Parle, on the Minnesota river, owes its existence to refilling of the Minnesota valley by the silt of the Lac qui Parle river.

In the city of St. Paul a very coarse valley deposit, allied with the modified drift, but consisting mainly of small and large fragments and blocks of the underlying Trenton limestone, is spread here and there on the level Trenton terrace plain, about 90 to 120 feet above the Mississippi and also about 100 feet below the tops of the valley bluffs. The coarse limestone debris, occasionally holding blocks of all sizes up to 20 or 30 feet in length or diameter, is seen in many places, but not continuously, along the distance of seven miles from the vicinity of Fort Snelling to the east part of the city, varying from a few feet to about 30 feet in thickness. With its commonly more or less waterworn masses derived from the Trenton limestone, which makes up nine-tenths or often nineteen-twentieths of the deposit, are everywhere scanty drift pebbles and less frequent boulders, brought from great distances at the north, which show for this unusual deposit an intimate relationship with the glacial and modified drift. It is nowhere overlain by till, nor by valley drift of the usual type. No description of this singular formation, illustrated in Plate IX, has been previously published.

Guided by helpful suggestions of Prof. C. W. Hall and Dr. F. W. Sardeson, I am led to ascribe this very coarse valley debris to erosion by the river at some time during the final recession of the ice-sheet, when the ordinary modified drift, continues with the wide floodplains of the Mississippi at Minneapolis, Fort Snelling, South St. Paul, Newport, and Langdon, had filled the valley just to the height of this limestone terrace. It is needful, however, to go back to a much earlier part of the Glacial period and thence bring forward a very important part of this explanation.

During some long interglacial stage, probably the Buchanan time of glacial recession next after the Kansas glaciation, southern Minnesota had been uncovered from the ice and the Mississippi here had sculptured its valley to nearly its present form, allowing prolonged erosion by rivulets and by weathering on this limestone tract, which reaches seven miles along the valley from southwest to northeast. This part of the valley, it should be noted, lies transverse to its general course both above and below; and it is also transverse to the directions of the glacial currents during both the earlier and later advances of the ice-sheet. Parts of the limestone surface became very irregularly channeled and decayed during this interglacial exposure of perhaps 15,000 years, as its duration is computed by Prof. N. H. Winchell from an interglacial drift-filled gorge of the Mississippi in the west part of Minneapolis. Afterward the valley here and nearly all of southern Minnesota were again covered by the readvancing ice-sheet during the Illinoian and Iowan glaciation, and were next uncovered, as I think, during the Wisconsin stage of the final departure of the ice. Then the river built up its floodplain of modified drift to a height that coincided closely with that of the limestone terrace, causing the mighty stream to flow there in rapids, carrying the limestone masses and finer debris short distances from their original beds, and in some places undermining and toppling down the very large limestone blocks.

This peculiar formation is well seen near the north end of the High Bridge, for a third of a mile thence westward, at numerous other places on that northeast side of the river through this city, and on the opposite side near the Edison school in West St. Paul. It is of very unusual and surprising character and aspect, quite unlike any other formation which I have ever found in much exploration of glacial and valley drift. Therefore the probable conditions of its origin have been sought, with the results here presented, and with the hope that other Minnesota students of glacial geology will more fully investigate the many interesting questions connected with the history of this valley during the Ice age.

December 5, 1905.

[*Paper N.*]

METEOROLOGICAL STATISTICS.

By William Cheney and T. S. Outram.

These statistics are a continuation of the personal Meteorological Observations began in 1864 by William Cheney, for many years a member of this Academy. The first table published by the Academy is in Bulletins vol. I, 1873-1879 pp. 174-186; the second in Bulletins vol. II, 1880-1882, pp. 422-435; the third, this volume, ante, pp. 123-130.

		THERMOMETER						PRECIPITATION IN INCHES				
	Mean Height of Barometer	Monthly Mean	Maximum	Minimum	Monthly range	90° or above	32° or below	Monthly	Total Snowfall	Percentage of Cloudiness	Relative Humidity	Prevailing Winds.
1895												
January	......	4.7	32	—25	57	0	31	1.08	10.80	....	....	N. W.
February	30.186	9.8	49	—30	79	0	26	.45	4.30	....	....	N. W.
March	30.039	28.	58	— 9	67	0	28	.51	.70	....	....	N. W.
April	29.968	52.1	80	25	55	0	4	1.59	0.	....	....	S. & S. E.
May	29.892	59.2	94	28	56	1	3	2.67	0.	....	....	S. & N. W.
June	29.928	67.4	87	41	46	0	0	3.40	0.	....	....	S. E.
July	29.922	70.	100	44	56	4	0	4.15	0.	....	....	W.
August	29.870	69.	93	46	47	4	0	2.27	0.	....	....	N. W.
September ...	29.850	65.1	94	30	64	7	1	4.69	0.	....	....	S.
October	30.025	43.1	71	14	57	0	16	.09	.50	....	....	N. W.
November ...	30.073	30.1	67	— 7	74	0	26	.94	3.70	....	....	S.
December ...	29.990	20.3	40	— 6	46	0	31	.23	1.00	....	....	S.
Total for Year	......	.....	100	—30	130	16	166	22.07	21.00	....	....	
Mean for Year	29.977	43.23	...	....	...	..	....	.....	.....	....	....	N. W.
1896												
January	30.176	15.	43	—21	64	0	31	.85	6.55	....	....	N. W.
February	......	20.4	61	—15	76	0	29	.26	2.60	....	....	N. W.
March	30.077	24.5	59	—11	70	0	30	3.02	11.80	....	....	N. W.
April	29.929	47.1	81	11	70	0	10	5.22	7.60	....	....	S. E.
May	29.825	63.3	90	39	51	2	0	3.92	0.	....	....	W. & S. E.
June	29.916	68.1	90	44	46	2	0	3.76	0.	....	....	S. E.
July	29.951	71.1	94	47	47	6	0	1.73	0.	....	....	S.
August	29.937	68.9	96	42	54	5	0	4.15	0.	....	....	N. W.
September ...	29.991	56.3	84	31	53	0	2	2.42	0.	....	....	N. W.
October	30.007	44.5	73	16	57	0	11	3.94	0.20	....	....	N. W.
November ...	30.110	21.1	50	—11	61	0	30	4.17	9.90	....	....	N. W.
December ...	30.128	22.3	44	—12	56	0	31	.83	4.70	....	....	N. W.
Total for Year	......	.....	96	—21	117	15	174	34.27	43.35	....	....	
Mean for Year	30.004	43.5	...	....	...	..	....	.....	.....	....	....	N. W.
1897												
January	30.15	8.6	46	—29	75	0	30	1.66	16.6	....	....	N. W.
February	30.06	19.2	38	—24	62	0	28	1.05	10.5	....	....	N. W.
March	30.08	23.5	60	—12	72	0	25	3.23	14.1	....	....	N. W.
April	30.02	45.2	78	20	58	0	11	1.61	.9	....	....	N.
May	30.02	56.6	90	30	60	1	3	1.92	.0	....	....	N. W.
June	29.92	64.7	100	31	69	1	2	9.40	.0	....	....	S. E.
July	......	73.8	97	53	44	6	0	4.93	.0	....	....	S. E.
August	......	66.8	86	47	39	0	0	1.84	.0	....	....	N.
September ...	30.10	66.3	91	33	58	3	0	1.97	.0	....	....	S. E.
October	30.05	51.8	84	24	60	0	5	1.67	.0	....	....	N. W.
November ...	30.15	28.5	69	—10	79	0	27	.97	4.9	....	....	N. W.
December ...	30.17	15.2	46	—15	61	0	31	.18	1.8	....	....	N. W.
Total for Year	......	.....	100	—29	129	11	162	30.43	48.8	....	....	....
Mean for Year	30.072	43.4	...	....	...	..	....	.....	.....	....	....	N. W.

	Mean Height of Barometer	THERMOMETER						PRECIPITATION IN INCHES		Percentage of Cloudiness	Relative Humidity	Prevailing Winds.
		Monthly Mean	Maximum	Minimum	Monthly range	90° or above	32° or below	Monthly	Total Snowfall			
1898												
January	30.10	21.5	42	—5	47	0	31	.08	.8	....	....	N. W.
February	30.16	19.2	44	—15	59	0	28	1.79	9.9	....	....	N. W.
March	30.06	33.6	60	7	53	0	28	1.65	13.1	....	....	N. W.
April	30.11	44.2	76	16	60	0	13	1.49	1.0	....	....	N. W.
May	29.94	51.2	83	35	48	0	0	5.53	.0	....	....	N. E.
June	29.92	68.2	93	46	47	1	0	4.82	.0	....	....	N. W.
July	29.96	71.5	92	48	44	3	0	.51	.0	....	....	S. E.
August	29.94	68.3	95	44	51	3	0	3.01	.0	....	....	S.
September ...	29.94	62.1	92	36	56	2	0	.81	.0	....	....	N. W.
October	30.00	45.	81	24	57	0	9	6.22	T	....	....	N. W.
November ...	30.00	28.7	58	—15	73	0	27	1.56	13.	....	....	N. W.
December	30.11	10.4	37	—25	62	0	31	.07	.7	....	....	N. W.
Total for Year	......	.....	95	—25	120	9	167	27.54	38.5	....	....	....
Mean for Year	30.05	44.2	....	....	....	....	....	....	....	....	....	N. W.
1899												
January	30.09	10.6	40	—31	71	0	31	.81	7.5	....	....	N. W.
February	30.12	5.8	47	—36	83	0	25	1.21	11.9	....	....	W.
March	30.08	16.6	34	—14	48	0	31	2.39	22.2	....	....	N. W.
April	29.96	46.7	85	11	74	0	8	1.15	T	....	....	N. W.
May	29.95	58.0	86	33	53	0	0	3.52	.0	....	....	S.
June	29.93	67.9	88	46	42	0	0	6.55	.0	....	....	S.
July	29.93	72.3	95	45	50	5	0	2.13	.0	....	....	S. W.
August	29.91	71.4	96	52	44	4	0	3.45	.0	....	....	S.
September ...	30.05	57.4	89	23	66	0	4	1.35	T	....	....	S.
October	30.04	49.8	80	27	53	0	3	3.54	T	....	....	S.
November ...	30.08	39.0	60	18	42	0	18	.38	.5	....	....	W.
December ...	30.12	18.5	49	—12	61	0	31	1.44	1.3	....	....	N. W.
Total for Year	......	.....	96	—36	132	9	151	27.92	43.4	....	....	....
Mean for Year	30.02	42.8	....	....	....	....	....	....	....	....	....	S.
1900												
January	30.11	18.9	47	—20	67	0	31	.55	5.1	....	....	N. W.
February	30.16	6.2	35	—21	56	0	28	1.00	10.	....	....	N. W.
March	30.11	24.1	53	—11	64	0	31	1.53	15.3	....	....	N. W.
April	30.06	50.7	82	22	60	0	11	2.06	1.2	....	....	S. E.
May	29.94	62.	92	29	63	4	3	.35	.0	....	....	S. W.
June	29.92	69.4	98	43	55	7	0	2.41	.0	....	....	N. W.
July	29.89	71.6	96	51	45	5	0	9.10	.0	....	....	N. E.
August	......	76.3	95	54	41	12	0	7.07	.0	....	....	S. W.
September ...	......	60.	92	33	59	1	0	7.53	.0	....	....	S. E.
October	29.98	56.1	79	31	48	0	1	4.81	.0	....	....	S.
November ...	30.15	27.4	61	7	54	0	24	.73	7.	....	....	N. W.
December ...	30.04	19.9	42	—13	55	0	30	.42	4.2	....	....	N. W.
Total for Year	......	.....	98	—21	119	29	159	37.56	42.8	....	....	....
Mean for Year	30.036	45.2	...	....	...	..	...	....	....	....	....	N. W.

		THERMOMETER						PRECIPITATION IN INCHES				
	Mean Height of Barometer	Monthly Mean	Maximum	Minimum	Monthly range	90° or above	32° or below	Monthly	Total Snowfall	Percentage of Cloudiness	Relative Humidity	Prevailing Winds.
1901												
January	......	12.5	41	—15	56	0	31	.40	4.	....	....	N. W.
February	30.10	9.5	37	—15	52	0	28	.36	3.6	....	....	N. W.
March	29.93	26.8	53	— 8	61	0	30	1.93	13.7	....	....	N. E.
April	30.11	48.4	88	22	66	0	14	1.82	.0	....	....	N. E.
May	29.94	59.7	91	31	60	1	1	1.89	.0	....	....	N. E.
June	29.85	69.2	96	36	60	5	0	6.67	.0	....	....	S. E.
July	......	77.4	102	53	49	13	0	1.64	.0	....	....	N. E.
August	......	72.2	93	48	45	6	0	2.65	.0	....	....	S.
September	......	60.	90	36	54	1	0	3.80	.0	....	....	W.
October	......	51.6	82	30	52	0	4	.94	.0	....	....	S. E.
November	......	31.	58	12	46	0	27	1.00	3.2	....	....	N. W.
December	......	15.9	44	—27	71	0	31	.46	7.2	....	....	N. W.
Total for Year	......	.....	102	—27	129	26	166	23.56	31.7	....	....	N. W.
Mean for Year	29.986	44.5	...	....	....	..	....	.....	.....	....	....	....
1902												
January	......	18.7	46	—17	63	0	31	.44	5.3	....	....	N. W.
February	......	18.2	52	—15	67	0	26	.47	4.4	....	....	N. W.
March	......	36.2	63	— 7	70	0	17	.30	1.5	....	....	S. E.
April	......	44.6	84	16	68	0	14	2.70	.8	....	....	S. E.
May	......	60.2	86	34	52	0	0	4.33	.0	....	....	S. E.
June	......	64.1	86	44	42	0	0	2.00	.0	....	....	W.
July	......	71.1	88	54	34	0	0	6.05	.0	....	....	S.
August	......	66.5	86	48	38	0	0	5.94	.0	....	....	S.
September	......	57.2	82	36	46	0	0	4.03	.0	....	....	S.
October	......	49.6	74	30	44	0	1	1.40	T	....	....	S. E.
November	......	36.	62	17	45	0	17	1.74	2.4	....	....	N. W.
December	......	15.6	39	—20	59	0	30	2.61	24.	....	....	N. W.
Total for Year	......	.....	88	—20	108	0	136	32.01	38.4	....	....	....
Mean for Year	......	44.9	...	....	....	..	....	.....	.....	....	....	N. W.
1903												
January	......	14.6	40	—14	54	0	31	.22	4.2	....	....	N. W.
February	......	14.8	42	—24	66	0	27	.50	2.5	....	....	W.
March	......	33.6	60	8	52	0	26	2.05	4.1	....	....	N. W.
April	......	45.1	73	24	49	0	12	3.02	1.5	....	....	N.
May	......	59.1	83	32	51	0	1	4.40	T	....	....	N.
June	......	65.4	85	40	45	0	0	1.02	.0	....	....	N. E.
July	......	69.4	92	51	41	1	0	7.29	.0	....	....	N.
August	......	65.1	88	48	40	0	0	4.61	.0	....	....	N. W.
September	......	58.2	82	37	45	0	0	7.77	.0	....	....	S.
October	......	50.	73	30	43	0	1	4.36	.0	....	....	S. E.
November	......	29.8	66	0	66	0	24	.37	2.5	....	....	N. W.
December	......	12.6	35	—19	54	0	31	.64	8.3	....	....	N. W.
Total for Year	......	.....	92	—24	116	1	153	36.19	23.2	....	....	....
Mean for Year	......	43.1	...	....	....	..	....	.....	.....	....	....	N. W.

	Mean Height of Barometer	THERMOMETER						PRECIPITATION IN INCHES		Percentage of Cloudiness	Relative Humidity	Prevailing Winds.
		Monthly mean	Maximum	Minimum	Monthly range	90° or above	32° or below	Monthly	Total Snowfall			
1904												
January	......	7.3	38	—33*	71	0	31	.43	8.5	....	....	N. W.
February	......	5.2	36	—19	55	0	29	.75	13.2	....	....	N. W.
March	......	27.7	53	— 4	57	0	29	1.64	5.8	....	....	N. W.
April	......	41.0	73	21	52	0	17	1.83	7.8	....	....	N.
May	......	57.6	84	35	49	0	0	3.54	.0	....	....	W.
June	......	65.6	83	48	35	0	0	3.81	.0	....	....	S.
July	......	68.4	†92	53	39	1	0	4.78	.0	....	....	W.
August	......	66.2	88	46	42	0	0	5.61	.0	....	....	S.
September	......	59.7	83	38	45	0	0	3.19	.0	....	....	S. E.
October	......	48.8	76	29	47	0	4	4.94	T	....	....	S. E.
November	......	38.6	69	12	57	0	15	.10	.3	....	....	N. W.
December	......	19.9	50	—11	61	0	30	.61	7.4	....	....	S.
Total for Year	......	......	....	....	...	1	155	31.23	43.0	....	....	....
Mean for Year	......	42.2	...	....	51	..	....	......	......	....	....	N. W.

* Minimum temperature —33° Jan. 24th.
† Maximum temperature 92° July 16th.

	Mean Height of Barometer	Monthly mean	Maximum	Minimum	Monthly range	90° or above	32° or below	Monthly	Total Snowfall	Percentage of Cloudiness	Relative Humidity	Prevailing Winds.
1905												
January	......	7.4	36	—18	54	0	31	.71	13.1	....	....	W.
February	......	11.9	56	—26	82	0	28	.59	9.3	....	....	N. W.
March	......	35.1	67	3	64	0	21	.73	1.0	....	....	S. E.
April	......	44.0	72	21	51	0	13	.74	T	....	....	N. W.
May	......	54.2	77	36	41	0	0	4.47	T	....	....	N. E.
June	......	64.9	85	45	40	0	0	7.11	.....	....	....	S. E.
July	......	69.8	93	54	39	3	0	3.02	.....	....	....	N.
August	......	70.8	95	50	45	2	0	4.32	.....	....	....	S. E.
September	......	63.7	84	43	41	0	0	6.50	.....	....	....	S
October	......	45.6	82	17	65	0	8	2.17	5.5	....	....	S.
November	......	35.2	61	— 8	69	0	22	3.07	11.5	....	....	W.
December	......	23.9	45	— 1	46	0	31	.06	1.9	....	....	W.
Total for Year	......	......	...	....	...	5	154	33.49	42.3	....	....	W-S. E.
Mean for Year	......	43.9	...	....	53	..	...	.....	.....	....	....	....

* Minimum temperature —26° Feb. 2nd.
† Maximum temperature 95° Aug. 10th.

Seasonal Temperature and Total Precipitation for the Years 1895 to 1905

Year	Jan.	Feb.	March	April	May	June	July	August
	TEMPERATURE							
	Winter { Dec. Jan. Feb.	Spring	Summer	Autumn	Mean	Maximum	Minimum	Precipitation
1895	15.7	47.5	69.5	47.6	44.6	96 Sept. 17	26 Feb. 5	21.44
1896	20.5	46.1	70.6	42.2	45.0	99 Aug. 4	18 Jan. 3	30.65
1897	18.3	42.6	68.2	50.6	44.1	96 June 13	26 Jan. 25-26	28.37
1898	19.6	46.0	70.5	46.5	45.6	97 Aug. 22	20 Dec 31	25.92
1899	11.9	41.2	71.1	51.1	44.4	96 Aug. 10	33 Feb. 9	24.93
1900	17.0	46.8	72.1	49.3	46.3	95 July 30	19 Jan. 31	34.89
1901	16.1	45.9	72.9	47.5	45.2	102 July 20	27 Dec. 14	22.30
1902	17.6	47.0	67.4	47.6	44.9	88 July 29	20 Dec. 26	32.01
1903	15.0	45.9	66.6	46.3	43.1	92 July 7	24 Feb. 16	36.19
1904	8.4	42.1	66.7	49.0	42.2	92 July 16	33 Jan. 24	31.23
1905	13.1	44.4	68.5	48.2	43.9	95 Aug. 10	26 Feb. 2	33.49

PLATE VII

Fig. I. Magnetite crystals nearly parallel in growth in a matrix of hampdenite. The dodecahedron and cube are prominent but the surface is rough, and on two sides a great number of minute octahedral facets are shown which suggests that the entire crystal is built up of octahedra.

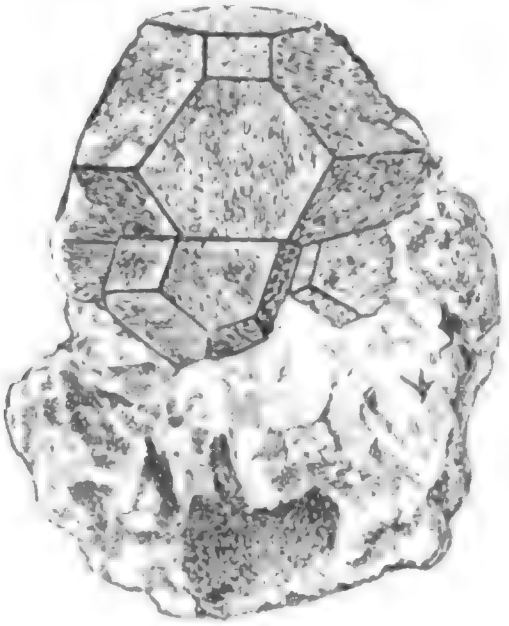
Fig. II. Magnetite and hampshirite in hampdenite. The magnetite shows a similar development of faces to Fig. I., but the octahedron is more prominently developed than in the preceding case and gives a striated appearance to the crystal and at one place gives a nearly smooth octahedral face beveling the solid angle of the dodecahedron. In both figures I and II the typical appearance of hampdenite is well shown.

Fig. III. Cast of a hampshirite pseudomorph after humite.

Figs. IV and V. Hampshirite pseudomorphs after humite showing typical development. Fig. V. shows the best detached crystal known to the author.

Fig. VI. Group of Hampshirite pseudomorphs after humite in hampdenite loaned by Prof. B. K. Emerson from the Smith College collection. This is the specimen referred to on page 274.

Fig. VII. Hampdenite showing smooth fibrous fracture.
Reduced one-half.



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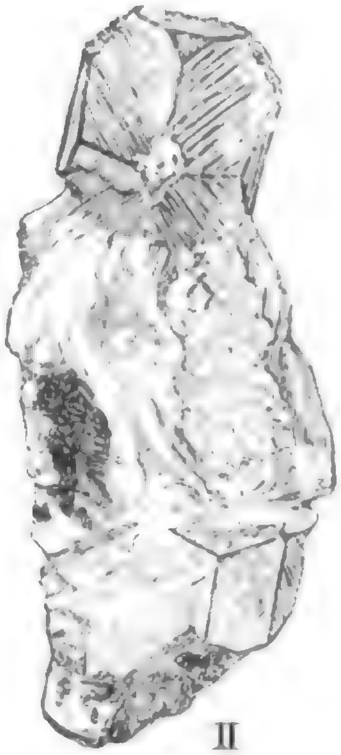

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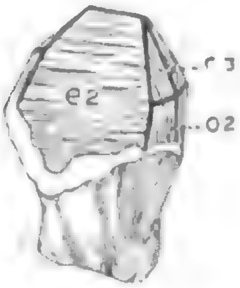

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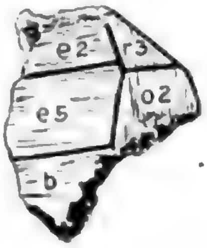

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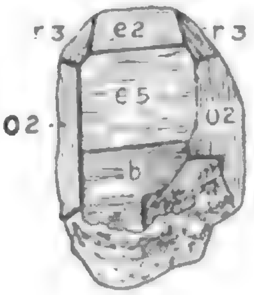
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e5
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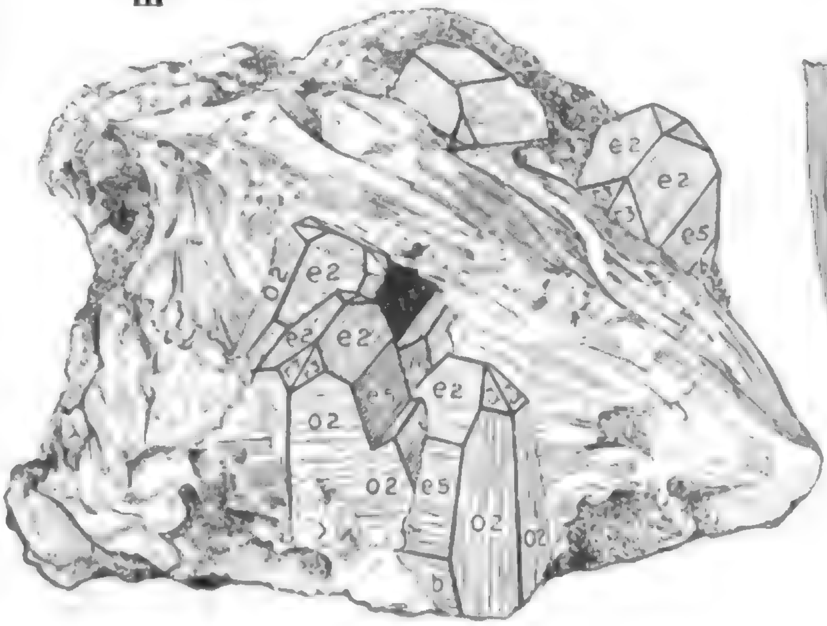
V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o2
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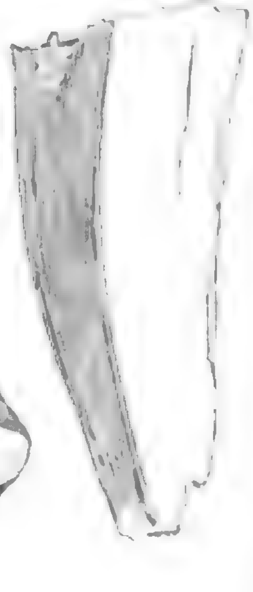
o2
b

VI



VII

PLATE VIII

Chimney Rock, Section 31, T. 114 R. 17 W., Marshan, Dakota County, Minn., looking southeast.

A spire of St. Peter Sandstone capped by a thin layer of more enduring Trenton limestone.

Photographed by Howard W. Crosby, Hastings, Minn.

PLATE IX

Coarse limestone debris, northwest bluff of the Mississippi river gorge near the High Bridge, St. Paul, Minn., showing beneath it the unevenly eroded top of the St. Peter sandstone.

Photographed by Prof. C. W. Hall.

PROCEEDINGS

OF THE MINNESOTA ACADEMY OF SCIENCE

MINNEAPOLIS, MINNESOTA

VOL. IV. BULLETIN III.

FOR THE YEARS 1906-1910

PLATES X AND XI

(EDITED BY A COMMITTEE OF THE BOARD OF TRUSTEES)

PROCEEDINGS OF THE MINNESOTA ACADEMY OF SCIENCE

(Abstracted from the records by Secretary Harlow Gale.)

278th Meeting, Jan. 6th, 1906, *Annual Meeting in the Art Gallery of Mr. T. B. Walker,* 807 *Hennepin Av.*

Present: President C. W. Hall, Winchell, Upham, Walker, Roe, Oestlund, Sardeson, Meeds, Arndt, R. J. Mendenhall, Benner, Nathan Butler, Dr. Chas. Simpson, Mrs. G. W. Tinsley, and Gale, with five lady and six men guests.

Historical program. Retiring President Hall reviewed, from 7:45 to 8:15 the growth of our city during the 33 years of the Academy, of Carlton, Hamline, and the State Universities, of similar Academies of Science in Philadelphia, Boston, New York, and Chicago, and then suggested the possibilities for the growth of our Academy in this large and wealthy state. He hoped our Academy would be the center for scientific research throughout the state and that thus it would grow out into the life of the State.

Moved and carried that the President appoint a nominating committee for the officers: Sardeson, Meeds, and Winchell being thus appointed.

A Historical Sketch of the Minnesota Academy of Science, compiled from the books of the Secretary and the trustees and from personal interviews, was read by the Secretary, Harlow Gale.

Personal Recollections were given:

On Geology, by N. H. Winchell.

On the Menage Philippine Expedition, by Pres. Hall.

On Dr. A. E. Johnson's work in Mycology, by Dr. Chas. Simpson, the first secretary of the Academy.

On the Museum, by Curator A. D. Roe.

Report of the Treasurer, Edw. C. Gale, read by Pres. Hall, showed balance of $233.41.

Report of Corresponding Secretary Oestlund showed accessions by exchanges during 1905 to be 712, total entries to date, 12,526. The revised exchange list, representing 127 Academies, Societies, Libraries, Museums, Universities, and Surveys, are distributed as follows:—European 93, American 79, South American 9, Australian 7, Asiatic 4, African 3; total 195. The great value of the Academy's exchanges, many being in no other library in this part of this country, and the wholly inaccessible condition of the books, were explained and emphasized.

In his address "On the Function and Future of the Academy", Mr. T. B. Walker referred to his first interest in the Academy in getting it moved from the East Side in the Kelly block in 1882, to his interest being mainly that of a business man, although he had formerly studied geology much and had read a paper in connection with the Academy meeting on Sanitary Science, which also touched his long-studied sociological subjects. As an active director in the old Athenæum he had been largely instrumental in forming the new Library, the president of whose board he had been since its organization. He recalled how the original plan of the organization of the Public Library was for a co-organization of the Athenæum, Academy and the Art Society. He had been instrumental in providing new cases needed by the Museum in the Library Building, and had presented minerals and other specimens to the collections. The great value of the museum as a means of public education was emphasized and the Library officers had realized of late what a persistent public demand there was to see the museum.

Thus, the Library Board, at its meeting yesterday, had decided to finish off the third floor in the new wing for the Academy's Museum, along with the fourth floor for the Art School. Thus the present building and quarters will last for some years, although we may look forward to a separate building sometime. For such a building some friend of his had spoken of offering $50,000 and others would doubtless help; for such an enterprise must be done by private means given for public purposes. Such a purpose is ,however, far more important to the State than most people realize.

The speaker's ambition for Minneapolis was to make it the educational center of this Northwest,—"We can make it the highest grade city in proportion to its size, in the world." The Academy of Science helps largely to make the city attractive to families and children. Thus he desires to see in our city one of the foremost libraries and museums in the country, so that it shall be the center of half the United States.

The Librarian, Miss Gratia Countryman, asked the privilege of telling the Academy that it was Mr. Walker's personal generosity which had made possible the immediate finishing of its museum room. She realizes more than ever the great educative value of the museum. She is decidedly not in favor of paid admissions, however, and she suggests a lease of the museum and library to the Library Board, similar t othe Athenæum arrangement, by which the Board will probably care for the Academy's property.

Mr. Walker suggested to first get the museum set up in good shape, then let the Library Board see how valuable it is, and it would then probably be glad to take charge.

Prof. Sardeson referred to the inducements to move the museum to St. Paul.

Additional words of reminiscence were given by Nathan Butler, who had been present at the early meetings in Dr. Johnson's office, by R. J. Mendenhall, who was almost an original member, by Franklin Benner, who desired to renew his active membership and hoped that many others would, by A. D. Meeds, a former secretary, by Mrs. F. L. Tinsley, the first woman member, and who was proud to be here again.

Moved by Winchell "That a vote of thanks be given Mr. Walker for the very pleasant surroundings amid which our meeting tonight has occurred." Unanimously carried. On Mr. Walker's assuring the Academy of its being very welcome, President Hall added one more item of our host's generosity; when he maintained a taxidermist for some months at $75 a month, setting up the Philippine collection, until the Omaha Exposition providentially came in.

The nominating committee reported as follows:—

President—T. B. Walker.

Vice President—N. H. Winchell.

Recording Secretary—H. Gale.

Corresponding Secretary—O. W. Oestlund.

Treasurer—Edw. C. Gale.

Trustees—C. W. Hall, A. D. Roe.

Moved and carried that the Secretary cast the ballot of the Academy for the above list. Done.

On being congratulated by President Hall, Mr. Walker accepted it with appreciation under the present conditions,—though he has refused many positions,—on the ground, that, as a business man, who has long been a trustee of the Academy, he can be more helpful to it in this official position.

On finding that the constitution makes a Vice President a trustee ex-officio, it was moved and carried that the secretary cast the vote of the Academy for O. W. Oestlund for trustee for the unexpired term of Winchell, i. e., for one year. Done.

The names of O. O. Whited and Dr. Frank Corbett were proposed by Winchell and Roe and were both unanimously elected. Adjournment at 11:00 p. m

HARLOW GALE, *Secretary.*

Special Meeting, Jan 11th, 1906, in President Walker's Study.

Present: Walker, Winchell, Norton, Roe, and H. Gale.

President Walker spoke of the plans for finishing the new Academy museum room, its heating by hot water and of its ventilation; of ultimately getting a large lecture room built in the court. Mr. Roe urged getting some women members and setting them doing something in the Academy's activity.

Mr. Winchell urged the providing of public scientific lectures, and then told of the possibilities of our giving Dr. Otto Nordenskjöld a reception. A committee of Winchell, Oestlund, and H. Gale was appointed to arrange for the reception. It was suggested to ask Professor Hall, as President of the Minnesota Geographical Society, to join the reception committee, also Miss Countryman, Mrs. Tinsley, and a representative of the Commercial Club. Adjourned.

H. GALE, *Secretary.*

Jan. 22d, 1906 a Public Reception was given to Dr. Otto Nordenskjöld and his bride by the Academy in President Walker's Art Gallery from 3 to 5 P. M.

The reception committee was composed of President and Mrs. Walker, Miss Gratia Countryman, Mrs. L. F. Tinsley, Prof. C. W. Hall, President of the Geographical Society of Minnesota, B. F. Nelson, for the Commercial Club, and Winchell, Oestlund, and H. Gale, as the Committee of Arrangements for the Academy.

Between 200 and 300 guests were present during the afternoon and everyone found it a most delightful occasion. Dr. Nordenskjöld spoke a few words in English, telling somewhat of his Antarctic experiences, as his public lecture on Jan. 23rd will be mostly in Swedish.

279 *th Meeting, Feb. 6th*, 1906, *Directors' Room, Public Library.*

Vice President Winchell in the chair. 18 persons present.

The following resolution on the death of the founder of the Academy, Dr. A. E. Johnson, was offered by the secretary, and it was moved and carried that it be adopted, recorded, and a copy sent to Dr. Johnson's relatives.

In Memory of Dr. A. E. Johnson.

Born Mar. 16, 1825. Died Jan. 27, 1906.

The Minnesota Academy of Science hereby records its profound appreciation of the rare ideal of a student of nature which was shown by "the Father of the Academy", Dr. Asa E. Johnson. His scientific knowledge, energy, and enthusiasm, as displayed by his generous devotion to the study of nature at our own doors, was the foundation spirit of the Academy. In his own field of original investigation, the Mycology of Minnesota, he has left a monumental record in the Academy's publications; while, among his eighteen other scientific papers, there is an astonishing accumulation of evidence for his broad scientific culture. Thus, besides being one of St. Anthony's foremost pioneer physicians, his intellectual life was tireless until health and strength failed.

To his guidance in this ideal scientific spirit, during the six years of his presidency and the ten years of his active membership, the Academy also records its deepest gratitude. He gathered an apostle group of similar lovers of nature about him in his own office, gave his own collections as the foundation nucleus of the museum; as a trustee and business man he gave generously of his time and means, while his quiet modesty in all this generous enthusiasm was only equalled by his fidelity to every detail of the Academy's life, both great and small.

May his genuine love of nature, his disinterested search for her minute secrets and great laws, and the application of this sincere knowledge to man's position in nature continue to be the motive spirit in this second generation of the Academy's life and be trans-

mitted as a growing heritage to the perpetual intellectual life of our beloved State!"

Personal recollections of Dr. Johnson were then given by Messrs. Roe and Upham, while Professor Winchell, as one of the charter members, gave quite a sketch, though informal, of Dr. Johnson's founding of the Academy, of the character and method of his work in the study of Fungi, and an enumeration and estimation of his published papers.

The names of S. R. Child and Prof. F. J. Wulling were proposed for membership by the Secretary and Mr. Roe and that of Edgar Reed by Mr. Roe and the Secretary; for all these the Secretary was directed to cast the Academy's ballot for membership. Done.

The following amendment to the constitution was offered by Mr. Roe, action to be taken at the next meeting: "To amend Art. 1 so that its name shall read 'Minnesota Academy of Science', and leaving out the word 'Natural.' Also that Art. 5, relating to the Board of Trustees, be amended so as to make 'the Vice President of the Academy an ex-officio member of the Board, and that four members shall constitute a quorum.'

At 8:45 Mr. H. B. Norton gave his report on "Some recent Studies of the Drift, bearing on the 'Great Geological Puzzle', illustrated by photographs and erratics from this vicinity." Mr. Norton described three kinds of glaciers: (1) stream, as in Switzerland; (2) mixed, as in Alaska; (3) the Piedmont, spreading out by its own weight. The speaker did not believe that the "Piedmont" form existed, and so did not bring drift. Only sharp rocks are reported on glaciers and there are no such sharp rocks in our moraines. The speaker's main point was that our drift was the result of water action and not glacial action. He cited the sand water deposit of some 50 feet in the Cedar Lake hill, the gravel cones in the Cannon river valley near Red Wing, his finding polished rock under the cones and circular striations around them, such as is done by water and not by ice. He described the gravel ring about Minneapolis, with sand toward the center and black earth in the center, such as would be made by a swirl of water. How could the soft rocks with mica, such as cannot withstand a single Minnesota winter, have been brought by the glacier? How could the field of some 500,000 rocks, from one half to about three quarters of a ton, polished all over, which were found around Franklin Av. and the river, have been made by ice? Then those rocks, which are too large to be rolled over and over, are not polished. Rocks, too, are found on the hills and alone in valleys: glaciers do not melt fast enough to do this work. The cross-hatched striation on the bed rocks appears to be the work of sea-ice rather than glaciers. The "terminal moraines" were regarded by the speaker as the shore beaches of this inland sea.

It was the sense of Mr. Norton's greatly interested hearers that he should continue his evidence at the next meeting and that there should be a chance for a discussion of the question. Adjournment at 10:20.

HARLOW GALE, *Secretary.*

280th *Meeting, March 6th*, 1906, *in the Directors' room, Public Library Building.*

Vice President Winchell in the chair: 24 members and guests present.

Moved by Roe that the amendment to the constitution changing the name to the "Minnesota Academy of Science", according to the notice given at the last meeting, be adopted. Seconded. After some discussion it was carried. Similarly, the other proposed amendment, adding the Vice President ex-officio as a member of the trustees, was adopted.

Mr. Roe again spoke of the desirability of getting women members and moved the membership dues of women be rebated from $5. to $2. for one year from date. Seconded and carried in the amended form "That membership dues required from lady members for one year from date be $5, but that $3 be remitted."

At 8:30 Mr. H. B. Norton resumed his presentation of the drift as due to water rather than glacial action. He quoted from Dawson and Alex. Winchell in support of this theory discussed the "Driftless Area" in Wis. as due to water alone, for it was not a plateau, as all the large rivers now ran through it, and he did not consider that the glacier came nearer it than the north shore of lake Superior, i. e., about 400 miles.

Animated discussion at 9 o'clock; Sardeson speaking of the personal equation in scientific work and described the Greenland glacier and what it probably could do here and the fact of large stones dropped in Iowa on fine clay.

Mr. Upham appreciated the speaker's observations, but reminded him that the glacial theory was not the work of any one man, but of many men, and any single observer's results must be compared with many others. He added that J. W. Spencer, the geologist of Missouri and Georgia, also held to the floating ice theory of Dawson, by whom he was educated. Yet the great majority of geologists held to the glacial theory.

Mr. Norton replied for ten minutes.

At 9:25 Professor H. L. Osborn of Hamline University, presented some "Remarks on Clinostomum Marginatum."

Adjournment at 10:10.

HARLOW GALE, *Secretary.*

281*st Meeting, April 3d*, 1906, *Directors' Room, Public Library.*

Vice President Winchell in the chair: about 25 members and guests present. An offer of a copy of Eaton's Ferns of America was received from Dr. W. H. Leonard. The offer of Henry W. Eustis' collection of butterflies and moths by means of a public subscription was explained by Winchell and Oestlund.

Professor O. W. Oestlund showed and explained an interesting specimen of a "Walking Stick", sent from Java. The names of Miss Gratia Countryman, Daisy S. Hone, Clara K. Leavitt and Elizabeth Foss were proposed by Mr. Roe for membership, duly seconded, and carried.

Individual letters were suggested to be written to our congressmen in favor or not in favor, according to our individual judgements, of the government's adoption of the metric system.

Owing to the absence of Prof. F. W. Sardeson, his announced paper "On the Primitive Discoid Crinoidal Root and Camarocrinus" was read by title.

At 8:30 Dr. H. L. Lyon, of the Botanical Dept. at the University of Minnesota, gave a review of the botanical experiments of Luther Burbank of Calif, as contained in Haywood's late book on Burbank, "New Creations in Plant Life", and compared with other sources. Discussion of the drift by Winchell and Norton. Adjournment late.

HARLOW GALE, *Secretary.*

282d Meeting, Tuesday, May 8th, 1906, *Directors' Room, Public Library.*

President Walker in the chair: 12 members and guests present.

The paper of the evening was "The Sewer System of Minneapolis: its Development, Topography, Geology, and Engineering Problems," by City Engineer Andrew Rinker. (Printed in this Bulletin:)

An animated discussion followed by Sardeson and Mr. Rinker on the proposed plan of diverting Bassett's creek through the chain of park lakes into Minnehaha creek.

President Walker then gave an informal tribute to Mr. Rinker's work for the city, praising his honesty, integrity, and judgement. Though on the other side in politics Mr. Rinker had been kept for 30 years in this office which is more important than that of mayor. The money has been expended in our Engineering Department as well as in any city in the country.

Moved by the President, seconded and carried, that Mr. Rinker be given a vote of thanks for his very interesting and intelligent address.

At 10:15 Vice President Winchell spoke on an endowment for the Academy, as he had suggested some years ago, by means of a donation from several lumbermen of cut-over land. He said some preparation ought to be made to present this to the next legislature. Moved by him, and seconded by Roe, that a committee of three be appointed by the President, of which the President should be the chairman, for the purpose of getting an endowment for the Academy. Carried. Discussion as to getting subscriptions. Adjournment at 10:30.

Immediately called to order again by President Walker. Moved, seconded and carried that the Secretary cast the ballot of the Academy for the following persons present for membership:—Dr. C. N. Spratt, Dr. P. A. Aurness, Professor Dr. T. G. Lee, Dr. E. J. Brown, and Mr. S. Lemere. Done. Adjournment at 10:45.

HARLOW GALE, *Secretary.*

283*d Meeting, June 5th*, 1906, *Directors' Room, Public Library.*

President Walker in the chair: about 15 members and guests present.

Mr. Henry W. Eustis exhibited his collection of some 3000 butterflies and moths, described his own interest and methods in collecting them, gave a considerable description of the specimens, and showed some of their evolutionary bearings.

Moved by Arndt that Mr. Eustis be given the Academy's thanks for his very interesting lecture and the exhibition of his collection, and urged him to publish a list of the Lepidoptera of Minnesota. Seconded by Winchell and carried. Adjourned at 9:40.

HARLOW GALE, *Secretary.*

284*th Meeting, Tuesday, Oct. 2d*, 1906, *in the Academy's new Museum Room.*

(In the second floor of the newly finished south wing of the Public Library Building.)

Vice President Winchell in the chair: 17 members and guests present.

After reading the minutes, as usual, the Secretary reported on the acquisition, during the past summer, of the collection of butterflies and moths, collected by Henry W. Eustis, by the raising of nearly $500.00 in subscriptions from friends of the Academy and of Mr. Eustis. The Secretary was asked to make arrangements for the formal presentation of the Eustis collection, which is now on exhibition near the door of the museum, in the name of the subscribers.

Mr. Roe, curator of the museum, then described the rehabilitation of the museum during the summer, after its being moved out of the way in the halls and the directors' room, from its former place in the corresponding room in the old wing (now used for the Art Book room), for the last two years. The expense of finishing this second floor of the new wing, as well as of the Art Gallery on the floor above, had been advanced to the Library Board by President T. B. Walker. Nearly $500.00 had been spent in cleaning and reinstalling the collections, $265 being for the renovation of the cases, nearly every one of which was somewhat broken, and putting new and heavy castors under them, $200.00 being for the services of Mr. Roe and his assistants in cleaning and arranging the collections in the cases. Little serious damage had, fortunately, taken place, although some specimens had disappeared.

Thus, after five weeks' work, the museum had been opened to visitors during the G. A. R. week in August and for State Fair week in September. Since then Curator Roe has been directed by the trustees to charge the former admission fee of ten cents for adults and five cents for children.

Mr. Roe then spoke of the necessity for a permanent curator to answer questions and give information, besides being a care-taker of the collections, and a mere watchman.

Prof. Sardeson spoke at length on the functions of the Academy, its museum, its young men, and its publications.

Miss Countryman, librarian of the Public Library, explained the relations of the Athenæum to the Library Board, and suggested, as she had before, a similar lease and conjunction between the Academy and the Library Board so that the Library would have more official connection with the museum for the purpose of caring for it.

A guest, Mr. David Boyle, of Toronto, Canada, was called upon and gave a most interesting talk, from his own experience as curator and his wide travel, on the needs and opportunities of a curator.

Informal reports were given by several members on their summer's scientific work or reading, especially by Sardeson, who gave a very interesting sketch of his accompaning a member of the U. S. Geological Survey on a trip through southern Minnesota for evidence on glacial work. Adjourned at 10 P. M.

HARLOW GALE, *Secretary.*

285*th Meeting, Wednesday, Nov. 2d,* 1906, *in the New Museum Room.*

Vice President Winchell in the chair: 13 members and guests present.

A paper "On some Modern Conceptions of Science" was read by Miss Julia B. Clifford, of the East High School. Discussion followed from 9:05 to 9:30 by Winchell, Random, Child and Gale. A vote of thanks and appreciation was moved by Roe and voted to Miss Clifford for her very learned, interesting, and stimulating paper.

As the hour was then so advanced Mr. Norton did not desire to begin his paper "On the Causes of Earthquakes", so it was agreed to postpone that subject until the next meeting. Adjournment at 9:45.

HARLOW GALE, *Secretary.*

286*th Meeting, Wednesday, Dec. 5th,* 1906, *in the New Museum Room.*

Vice President Winchell in the chair: about 20 members and guests present.

A paper "On the Causes of Earthquakes" was read by Mr. H. B. Norton, giving an extensive review of the causes (1) by volcanoc action, and (2) by faults of the earth's crust.

Mr. Upham then gave a detailed account of the late California earthquake, based on an article he had lately written for the Victoria Institute of London.

Discussion followed by Arndt, who asked Winchell about the fault at Hastings; by Random on the physics of wave propagation in rock and soil; by Norton, who objected to classing faults with smaller veins and joints; while Winchell regarded them as only different degrees of motion of the earth's crust .Thus, after a most interesting meeting, the Academy adjourned at 10:10.

HARLOW GALE, *Secretary.*

287th and Annual Meeting, Tuesday, Jan. 8th, 1907, *in the New Museum Room.*

Vice President Winchell presiding: 25 members and guests present.

The treasury balance, reported by the Treasurer, Edw. C. Gale, had increased during the year from $223.41 to 242.98, due to a participation in the admission receipts to the museum.

The Corresponding Secretary reported: Acquisitions during 1906, making a total of.... numbers in the Academy's library.

The Recording Secretary offered the following memorial:—

"The Minnesota Academy of Science wishes to make a slight record in memory of our life member, Mr. R. J. Mendenhall, who died Oct. 25th, 1906, aged .. years. Mr. Mendenhall was elected a member of the Academy on Mar. 4th, 1873, at its first regular meeting after its organization. He kept up his active membership until 1890, when he became one of our two life members (the other being Bishop McGolrick). His scientific interest is evidenced by his faithful attendance at the meetings for many years and by his three papers, read before the Academy, on his entomological and botanical subjects which he loved and lived with during his long and beautiful life. The silent beauty of the flowers, which he cultivated and studied, was a most fitting environment and reflection of his own serene, peaceful, and lovely life."

Moved by Child, and voted, that this memorial be adopted.

At 8:30 Mr. A. Jackson, Resident Engineer of the Great Northern Railway, described "The Filling-in of the Bryn Mawr marsh Bog" for the new freight yard. Abstract as follows:

In 1895 it was decided that more room was necessary for the Clearwater freight yard and the only available ground was across the Bryn Mawr swamp. Consequently we determined to fill the same with material from the high cliff at Cedar lake. The steam shovel started work at Cedar lake pit on Aug. 29, 1905.

The Bryn Mawr bog extends from a point about 400 feet west of Laurel Ave., measured along the tracks as they originally existed, to within a couple of hundred feet of Superior Av, a total distance of from 1,200 to 1,500 feet. The bog consists of a peat bed on top, from 1½ to 7 ft. thick, lying on a stratum of shell formation from 6 to 12 ft. thick, and below this a deep stratum of greasy clay.

Shortly after the filling-in began soundings were taken with a ⅝-inch sounding rod, such tests being taken about 50 ft. apart, and the work was done by hand. With such power we were only able to get down to a maximum of 30 ft. As it was very hard to get the rods down to this depth we supposed we had gotten into a good solid foundation to support the filling. But soon the track began to settle 2 to 3 ft. in a night, and great cracks would appear, showing where the underlying foundation had settled or slipped out. This happened repeatedly and some said that the Bryn Mawr bog could never be filled, but there was foundation somewhere between Minnesota and China, and so we kept filling in.

During March, 1906, four holes were sunk with a well-drilling machine. Hole No. 1, as shown on the diagram, was just outside the limits of the new fill and opposite the point of greatest settlement. The drill was put down to a depth of 92 ft. and was still in greasy clay. At this depth the drill buckled on account of the lateral pressure from the entire ground moving toward the north. Hole No. 2 was sunk outside the fill in the same manner, and at a depth of 62 ft. we ran into a gravel stratum underlying the clay, and in this gravel we struck a flowing well. Hole No. 3 was sunk to a depth of 58 ft., when we encountered gravel and a flowing well. Hole No. 4 was sunk through the new fill at about the point of greatest settlement. At a depth of 71 ft. the drill was still in our new gravel filling. As the grade of the new fill was only 12 ft. above the natural surface of the ground this showed that the settlement at that point was 58 ft., or, in other words, that the original material had been shoved out ahead of the filling to the depth of 58 ft. The settlement, however, did not stop at this point, for it was necessary several times afterwards to raise the fill to keep the embankment up to the established grade. Thus I estimate that the total settlement was from 80 to 90 ft. At this depth a firm bottom was evidently found, for, although there has been a little settlement since, I think this is more from the material packing, as is experienced in all new fills during the fall and winter.

Thus the filling stopped July 20, 1906, nearly 11 months after it was begun, and, instead of the estimated material of 211,000 cubic yards, it required about 500,000 cubic yards. The greasy clay in the bog, which slid or was pushed out ahead of the gravel filling, raised up a crescent-shaped tract of several acres to the north of the tracks, towards Laurel Avenue, to about 20 ft. higher than its natural bog level, seaming it with great cracks several feet wide and deep.

After many questions and much examination of Mr. Jackson's plan and fine series of photographs Mr. Winchell followed at 8:50 with "A Review of the Geology of the Bassett's Creek Valley," of which the following are the notes: This Bryn Mawr marsh or bog is only part of the large region like the Mississippi gorge below the falls. The speaker was first attracted to the subject in 1876, as State Geologist. The gorge between here and Fort Snelling was different from that above and below the city. He found the Bassett's gorge went through the chain of lakes (Isles, Cedar, Calhoun, and Harriet) and thence, in some unknown way, into the Minnesota river. Bassett's creek flows over the morainic drift and strikes the surface materials of the old gorge about Inglewood springs. The Glenwood-

Inglewood springs are not really springs, but artesian wells through the same strata as found in Mr. Jackson's test holes.

Another gorge the speaker found from the mouth of Rice creek, 15 miles up the river, off east through the chain of lakes north of St. Paul to the mouth of Trout creek at the foot of Dayton's bluff in St. Paul. Although not so definite a valley, this was a more direct route than either of the two later right-angled courses. As the Mississippi river or its ancestor always existed somewhere here between the archaen areas in Wisconsin and in Minnesota, this Rice and Trout creek valley was undoubtedly an ancient course of the Mississippi river. This course was interrupted by the first glacier, that which came from the northeast, until its deposited till filled the old straight gorge and turned the river into the forge of the Bassett's creek valley.

After a long interglacial period came another glacial disturbance from the northwest which cut off the Bassett's creek course and turned the river into its present channel between here and Fort Snelling. The speaker measured the recession of the falls since Hennepin's time and calculated therefrom that from 7,000 to 8,000 years had been occupied in cutting this third and last gorge from Fort Snelling to the Falls of St. Anthony. Applying this datum to the Bassett's creek route it makes some 15,000 years for the excavation of the Bassett's creek gorge.

There is no possibility of measuring in years the first Mississippi route by way of Rice creek to Dayton's bluff in St. Paul.

In the discussion following Mr. Upham spoke of the great value and importance of Professor Winchell's early estimate of the river's cutting, along with that of Niagara. Professor Winchell's calculation of the date of the last Glacial epoch having preceded that based on the recession of Niagara falls by Gilbert. Prof. Sardeson spoke of the bog at Eden Prairie on Purgatory creek, where the M. & St. L. Ry. had put in a large cement culvert which was cracking and going apart with the continued settling of the filling; also of a bog in England which was covered with a layer of cotton waste and then evenly with dirt so as to permit no bulging in any one part; also of a small bog by lake Phelan near St. Paul.

The nominating committee, Norton, Oestlund, and Spratt, reported in favor of the re-election of the present officers. Moved by Child, seconded, and carried that the Secretary cast the ballot of the Academy for the re-eelction of the present officers. Thus the following were elected for 1907:

President: T. B. Walker.

Vice-President: N. H. Winchell.

Recording Secretary: Harlow Gale.

Corresponding Secretary: O. W. Oestlund.

Treasurer: Edw. C. Gale.

Trustees: Dr. T. S. Roberts, O. W. Oestlund.

Prof. Oestlund spoke again of the necessity of moving the Academy's books from his laboratory, or he himself would have to move out; also that the risk of fire there was too great for the valuable accumulation of from $3,000 to $4,000 worth of books received by the Corresponding Secretary yearly. He moved that a committee be appointed to collect and remove to this new museum room all the books and pamphlets of the Academy.

Secretary Oestlund was appointed to effect this removal. Adjournment at 10:15.

H. Gale, *Secretary.*

288th Meeting, Tuesday, Feb. 5th, 1907, *in the Academy's Museum Room.*

President Walker presiding; nearly 30 members and guests present.

Mr. Gilbert Random, of the North High School read a thorough "Review of the Various Theories of Gravitation" from 8:10 to 9.

The discussion was opened by President Walker, who had had much interest and thought on this subject since his study of Newton's Principia in his young manhood.

Vice-President Winchell expressed his admiration for the learning showed in the paper, but confessed that the present conflicting and highly developed theories were too complicated for him to understand without special study. After further discussion Mr. Random added some closing explanations.

At 9:30 the Secretary gave some informal "Notes on the history of Mind Cures, especially of 'Christian Science' in Minneapolis." These notes were begun 20 years ago, when the first general interest in mental healing was evident in Minneapolis and before the special form of "Christian Science" was heard of here. All the various forms of mind cures were reduced by the speaker to the simple practice of suggestion, even though its physiological connection of mental expectation and accession of bodily vigor was not as yet known. Considerable discussion followed.

The removal of the Academy's library from various places at the University to the Museum room was announced. Adjournment at 10:05.

H. Gale, *Secretary.*

289th Meeting, Tuesday, March 5th, 1907, *Directors' Room, Public Library.*

President Walker presiding; about 100 members and guests present.

Dr. Thomas S. Roberts gave a most valuable and interesting description of "Bird Life in Minnesota," illustrated by about 100 from his own original collection of some 800 lantern slides photographs of birds of Minnesota and their habits.

At the conclusion of this memorable occasion a vote of thanks to Dr. Roberts was proposed by President Walker, and was carried enthusiastically and gratefully by a unanimous rising vote. Adjournment at 10:10.

H. Gale, *Secretary.*

290th Meeting, Tuesday, April 2d, 1907, *Directors' Room, Public Library.*

Professor C. W. Hall was called to the chair at 8:10 in the absence of President Walker. About 100 members and guests present.

A paper on "The Prehistoric Aborigines of Minnesota and their Migrations" was read by Professor N. H. Winchell and is already printed in the "Popular Science Monthly," September, 1908. (Abstract in this bulletin).

After some discussion of this scholarly and interesting paper the Academy adjourned at 10 P. M.

H. Gale, *Secretary.*

291st Meeting, Tuesday, May 7th, 1907, *Directors' Room, Public Library.*

President T. B. Walker presiding; 25 members and guests present.

The Secretary offered the following memorial, which was then ordered to be inserted in the minutes of the Academy:

"The Minnesota Academy of Science wishes to record its loving remembrance and scientific appreciation of its charter member, Dr. W. H. Leonard, who died April 29th, 1907, aged 82 years. As one of the charter members of the Academy Dr. Leonard was electetd a trustee at its organization on Jan. 6th, 1873. He was for some years chairman of the sections on the Archeology and Botany of the state and made several reports, specially his report on 'Ferns' in 1876. His well known interest in the hygiene of the city was shown in the Academy by his getting a committee to examine the water of the chalybeate Springs opposite lower Hennepin Island, at about the foot of 5th Avenue S. E.

"He was one of the dozen faithful attendants at the Academy's meetings during its early years; he kept up his active membership for over 20 years, and maintained his intellectual interest in the Academy to the last.

"His gentle, kindly heart and his alert scientific intellect, in the midst of a busy physician's life, will always be held in affectionate remembrance and civic honor."

At 8:15 the paper of the evening, "The Weather and Weather Forecasting," was given by Mr. H. E. Osborn, of the Central High School. The speaker described the great variety of popular weather signs and the kinds of professional individual forecasters. He then described and showed some of the apparatus and methods of the U. S. Weather Bureau.

Our new section director of the Government Bureau, Mr. U. G. Purcell, then expressed his appreciation of Mr. Osborn's interesting and instructive paper, said the Government was anxious to spread the knowledge of its methods (this in contrast to the secrecy of the professional individual forecaster) and added some details from his 22 years experience in the Weather Department. More discussion followed,—President Walker speaking of the U. S. Bureau's method having left philosophizing and practiced instead Bacon's inductive method based on a large collection of facts.

President Walker reported informally that the committee for the re-incorporation of the Academy as a state institution had met with such legal obstruction for such proposed legislative enactment that the project had to be abandoned. He also said that, although nothing definite had been done towards a permanent endowment, he still hoped that the Academy would some day be in its own building with an endowment.

After a suggestion by Winchell and some discussion it was moved, seconded, and carried that the Academy, through its president, vice-president, and secretary, should offer an invitation to the American Association for the Advancement of Science to hold in Minneapolis its meeting after the next, i. e., in 1908-9. Adjournment at 10 P. M.

H. Gale, *Secretary.*

292*d Meeting, June 4th*, 1907, *Directors' Room, Public Library.*

President Walker presiding; 16 members and guests present.

Professor N. H. Winchell read a paper on "The Mammoth in Minnesota," illustrated by a newly found tooth, the property of our member, Mr. O. O. Whited. At the conclusion President Walker recalled the presence in our Museum of a large mammoth tooth, which he had given the museum some years ago.

At 8:45 Professor O. W. Oestlund spoke on "Celebrations of the Linné Anniversary," calling special attention to Linné as a zoologist, or indeed, as a biologist, which broad scientific characters of the great man are too often lost sight of in his fame as a botanist. The speaker also described his extraordinary power as a teacher and as a writer of some 100 books in Latin.

President Walker announced that, through the action of the Library Board, the curator of the museum, Mr. A. D. Roe, had been provided with sufficient income and an assistant, so that the museum could be now kept open all day and every day, and with free admission.

Mr. Whited asked as to the age of the Esquimaux compared with the Mound Builders, and was answered by Prof. Winchell that the Esquimaux was here before, during, and since the Mound Builder, living on the edge of the ice field. On further questions Mr. Upham caller attention to Prof. Winchell's articles 30 years ago on the identity of the Mound Builder and the worker of the ancient copper mines of lake Superior, also to his present series of articles on "The Antiquity of Man," now running in "Records of the Past."

The President reported having written the proper officers of the

A. A. A. S., inviting the Association to hold its 1908-9 meeting in Minneapolis. Adjournment at 9:45.

H. GALE, *Secretary.*

293d *Meeting, Tuesday, October 8th,* 1907, *in the Academy's Museum Room.*

President Walker presiding; 12 present.

A report from Curator Roe was read, describing the increased attendance at the museum since it was opened free through the Library Board's paying the curator a salary, and suggesting that the library of the Academy be put in shape for use.

The program of the evening being "Informal Reports of our Summer's Scientific Work or Reading" Professor Winchell reported a curious accidental deception. On examining a supposed meteoric stone by thin sections he found it a fine-grained fragmental rock, with metallic substances on the outside. As he could not account for this external metallic substance it finally occurred to him that it might be aluminum which had rubbed off from his pocket magnifying glass, as he had carried them together in his pocket. Such proved to be the case, and he found similar aluminum specks on other stones of his collection. He also called attention to some apparent Indian Mounds on the Pacific coast in Oregon, which were now believed, as described by Mr. Upham earlier, to be of drift or terminal moraine origin. The nature and origin of the iron ore in the Mesabi Range, which he had visited again this summer, were discussed by Professor Winchell.

President Walker described his first buying of iron lands in the Mesabi Range about 25 years ago, and his tracing the veins of iron by the hills, water courses and the magnetic needle.

Professor Oestlund reported a six weeks visit to Vancouver, Id., and his special studies in plant lice, some three-quarters of his 30 species collected there being new to science.

Dr. Sardeson reported having been engaged all summer in a search for pottery clay near New Ulm and the discovery of it where other searchers had not found it.

Professor Lange, of St. Paul, reported having studied on the north short of lake Superior the influence of wild mammalian life on trees and animal life. Moose and deer, of which he had seen 36 and 35 respectively in five days, had killed the willows and kept down the mountain ash, birch, poplar, and June-berry; they had not touched the spruce, fir, and black alder, but water lilies had been eaten, leaves and stalk.

The Secretary reported having found a delightful and instructive picture of German student life 60 years ago, and of a country physician's work in Dr. Kussmaul's "Jugenderrinerungen." Adjourned at 10 P. M.

H. GALE, *Secretary.*

294th Meeting, Monday, November 4th, 1907, *Academy's Museum Room.*

Vice-President Winchell presiding; 13 present.

Mr. E. E. Woodworth, St. Paul, was proposed for membership and elected.

At 8:20 Professor C. W. Hall gave a very interesting paper on "North American Waterways," beginning with an outline of the river systems of both North and South America, then giving details of the proposed improvements of our Mississippi Valley system .

Discussion followed until adjournment at 10:10.

H. Gale, *Secretary.*

295th Meeting, Monday, December 2d, 1907, *Academy's Museum Room.*

President Walker presiding; 12 present.

The President reported informally that the Academy's invitation to the A. A. A. S. to hold its 1908-9 meeting here had been sent to some 20 societies and institutions of the state to join the Academy in this invitation. If this invitation is accepted it will be 25 years since the previous meeting of the A. A. A. S. here. The Secretary of the American Economic Association had also been written to by the President, who was authorized to extend the same invitation to this body.

At 8:20 Dr. F. W. Sardeson began a paper in "The Principle of River Erosion," being a criticism of the usual view as described by Salisbury and Chamberlin, and showing its application to the Mississippi river from Fort Snelling to the Falls of St. Anthony.

Discussion by Winchell, Upham, Hall, Norton, and Walker. Adjournment at 9:45.

H. Gale, *Secretary.*

296th and Annual Meeting, Monday, January 6th, 1908, *Academy's Museum Room.*

President Walker presiding; 15 persons present.

The President reported informally that the invitation of the Academy, seconded by some 20 other state organizations, had been presented last month to the A. A. A. S. at its Chicago meeting and our cause forcibly presented by Professors Winchell, Hall and himself. They found that Baltimore had been already selected by the committee for the next meeting and that Boston had been in the minds of the committee for the following one. But no official action had been taken on this latter, and, after the presentation of the claims of Minneapolis, our committee was assured that Minneapolis had every prospect for this meeting of 1909-1910. This would probably be a summer meeting, but a regular, not a special one.

The paper of the evening was by Mr. Warren Upham on the "Progress of Discovery of the Mississippi River, with special reference to Minnesota and its Geography." Discussion of this very able and interesting paper by Hall and Walker.

The year's report of the Academy's Treasurer, Edw. C. Gale, showed a decrease in the balance from $242.98 to $34.29, being due to the publication of Bulletin Vol. IV, No. 2, costing about $200.

Notice was given of a proposed change in the By-Laws, whereby the meetings should be held on the first Monday of the month instead of the first Tuesday after the first Monday.

Moved and carried that Oestlund and Gale be a committee to arrange for some disposition of the Academy's library to the Public Library Board, similar to the agreement with Athaeneum, and report at the next meeting.

Committee on nominations,—Upham, Hall, and Norton,—reported the following list for 1908 and they were electetd:

President: T. B. Walker.

Vice-President: F. W. Sardeson.

Corresponding Secretary: O. W. Oestlund.

Recording Secretary: H. Gale.

Treasurer: Edw. C. Gale.

Trustees for three years: N. H. Winchell and Edw. C. Gale.

Adjourned at 10:30.

H. GALE, *Secretary.*

297*th Meeting, Monday, February* 3d, 1908, *in the Academy's Museum Room.*

President Walker presiding; 25 members and guests present.

The paper of the evening, "Healing Forces in Nature," was read by Mr. H. B. Norton, dealing with the natural forces in the mineral vegetable, and animal kingdom, down to the present form in Christian Science, which was nothing new in essence.

President Walker remarked on the paper, and then spoke of plans for building up the Academy, and of its history and relations to the Library Board. He hoped there would be a hall built in the court of this building for public lectures and meetings. He also hoped that before many years the Academy would have a building of its own, or in conjunction with art, where books would be more incidental; so rather the opposite of the present situation.

The draft for a contract between the Academy and the Library Board, similar to that with the Athenæum, and drawn up by our treasurer, Mr. Edw. C. Gale, was read and discussed. Moved that this contract be received and accepted, subject to such changes as the Library Board may deem necessary, but that the term of the contract be for not more than three years. Carried.

Wm. P. Johnson, 1019 W 28th St., was elected to membership on the motion of Winchell and Walker.

The Amendment to the By-Laws, making the first Monday in the month the day for the regular meetings instead of the first Tuesday after the first Monday, was moved and carried, having been duly presented at the last meeting. Voted that the Secretary get together a list of the Academy's officers and members and make out "Sections" in accordance with the plan of the trustees. Adjournment at 9:50.

H. Gale, *Secretary.*

298th Meeting, Monday March 2d, 1908, *in the Museum Room.*

Professor Winchell presiding: 25 members and guests present.

Discussion as to the proposed agreement with the Library Board as to the Academy's library. Mr. F. H. Carlton, of the Library Board, spoke of the Board's attitude of assistance and also of the uncertain character of the Academy's books and the uncertain expense of properly binding the books.

A similar proposition to receive, bind, and catalog and use the Academy's books, the Academy to retain the ownership, was received informally through Prof. Oestlund from the University Library. After discussion it was moved by Prof. Wulling, seconded ,and carried, that this proposition of the University Library be also considered at the next meeting.

Considerable discussion followed as to the procuring of an original design for the Academy's stationary and publications through an open competition from art or school students.

Owing to the sudden illness of Mr. Horace V. Winchell, Geologist of the Great Northern Railway, Mrs. Winchell read his paper on "The Origin of Ore Deposits", and showed a rare collection of specimens of ores and ore-bearing rocks. The Academy was greatly indebted to Mrs. Winchell for her clear, interesting and intelligent presentation of this original and highly valuable paper, and for her participation, likewise, in the discussion which followed. Adjournment at 10:10.

H. Gale, *Secretary.*

299th Meeting, Monday, April 6th, 1908, *in the Museum Room.*

Vice President Sardeson presiding: about 25 members and guests.

The following memorial was offered by the Secretary:

"In Memory, of A. D. Roe, born June 28, 1825; died March 20, 1908.

From his earliest young manhood our late venerable and beloved curator of the Academy's museum has been a lover and student of nature. Amid his varied studies of law, education, and theology Mr. Roe has always studied the earth's history in the plants and rocks. Throughout his active educational life of some thirty years as a teacher, pastor and home missionary, his never failing source of bodily refreshment and mental invigoration has been these tramps for the collection of his plants and minerals, with the subsequent examination and classification of them in his study. Thus his study at home has been gradually filled with a large and valuable collection of rare and beautiful minerals and fossils.

On removing to Minneapolis in 1894 Mr. Roe soon discovered our Academy and its modest museum. He was elected a member on Feb. 9th, 1897, was secretary for the two years of 1898-1900, and a trustee from 1900 continuously until his death. He was the first permanent curator of the museum, being appointed in 1899; and it was to his knowledge, experience, scientific enthusiasm, and business ability in this curatorship that the Academy is chiefly indebted for being guided successfully through a trying period of its existence.

On the reopening of the museum in its present quarters on the third floor of the west wing of the Public Library Building, after being closed from the winter of 1903-04 to the summer of 1906, our then 80-year-old curator worked all summer with the enthusiasm of youth in renovating and rearranging the collections. Undoubtedly his interest in his scientific activity and in the Academy's museum was one of the main factors in prolonging his not naturally robust life to the rare and ripe age of nearly 83 years.

The memory of the life and works of our colleague will be one of the most precious records in the annals of the Academy."

Moved, seconded, and carried that this memorial be recorded in the minutes of the Academy.

The Secretary reported that the deed of sale of the Henry W. Eustis collection of butterflies and moths was now in the hands of the Academy's Treasurer, and that the transaction was closed to the mutual satisfaction of both parties, about $465.00 having been raised by subscription from the friends of the Academy and of Mr. Eustis for this purpose.

At 8:30 the paper of the evening, "The Opsomic Theory and the New Hygiene," was read by Professor Dr. F. J. Wulling, Dean of the College of Pharmacy of the University of Minnesota. The very scolarly and interesting paper was discussed by Dr. H. L. Ulrich and others. It has since been published in the *Northwestern Druggist*. Adjournment at 10:10.

H. Gale, *Secretary*.

300th Meeting, Monday March 2, 1908, *in the Directors' Room.*

Minutes and business were dispensed with in favor of the speaker of the evening, Professor D. Lange, of the Humbolt High School, St. Paul, on "Birds and Wild Animals of Northern Minnesota", illustrated by many original photographs, as lantern slides, of birds and deer in their natural habitat. The large audience was intensely interested in this most original and delightful address and exhibition.

H. Gale, *Secretary*.

301st *Meeting, Monday, June* 1, 1908, *in the Museum Room.*

Vice President Sardeson presiding; about 15 present.

Cor. Sec'y. O. W. Oestlund showed and described a "Goliath Beetle" from Africa.

Professor N. H. Winchell read a very interesting and original paper on the historical inaccuracy of the new historical painting in the State Capitol, illustrating the discovery of the Falls of St. Anthony. Discussion. [Published in this Bulletin.]

H. GALE, *Secretary.*

302d *Meeting, Monday Oct. 5th*, 1908, *as the invited guests of the Engineers' Club, at its club room,* 17 *S. 6th St.*

To hear a most interesting paper by Professor C. W. Hall on the "Water Supplies of the Twin Cities."

Present from the Academy among the entire audience of some 50 were Hall, Sardeson, Winchell, Rinker, Norton, Spratt, Roberts, and H. Gale.

Discussion joined in by Winchell, Sardeson, and Rinker. Adjournment at 11.

H. GALE, *Secretary.*

303d *Meeting, Monday, Nov. 2d*, 1908, *in the Museum Room.*

President Walker presiding: 12 present.

The museum's new curator, Mr. J. W. Franzen, was introduced.

A most interesting and valuable paper on "The Prairie Flora of western Minnesota" was read by Mr. Lycurgus, R. Moyer, of Montevidio. (Printed in this Bulletin).

Discussion from 9:20 to 10 by Leonard, Upham, Hall, Walker and Gale.

H. GALE, *Secretary.*

304th *and Annual Meeting, Monday Jan. 4th*, 1909, *in the Directors' Room.*

Vice President Sardeson presiding 10 members and two guests present.

Moved by Winchell that, in consideration of the absence of President Walker from the city, the annual election of officers be postponed until the Feb. meeting. Seconded and carried.

Corresponding Secretary Oestlund reported 652 additions to the Academy's library during 1908.

Treasurer Edw. C. Gale reported a balance of $15.89 as against $34.39 a year ago.

At 8:30 Mr. H. B. Norton began a "Symposium on the Geological Aspect of the City Water Supply Problem of the Twin Cities." He gave evidence to show the slow rate of filtration of water through sand rock. Evidence against this was offered by Winchell, and the discussion was continued by Sardeson and Mr. Walter S. Pardee. Adjournment at 9:50.

H. Gale, *Secretary.*

305th Meeting, Monday, Feb. 8th, 1909, *in the Museum Room.*

President Walker presiding: 11 present.

A letter from secretary Howard, of the A. A. A. S., was read by Winchell saying that the meeting for the holiday week of 1910-1911 was fixed for Minneapolis and requested to be advised of the committee of arrangements. After considerable discussion it was moved, seconded, and carried that a committee of five be appointed by the president, of which he should be a member, to select a local committee of some 100 members from Minneapolis and St. Paul, and make all the arrangements for this meeting of the A. A. A. S.

The following record of the death of Mr. Thomas Lowry on Feb. 4, 1909, was offered by the Secretary and was adopted and ordered sent to the press and the family:

"The Minnesota Academy of Science, like so many other organizations of our city and state, wishes to record its great loss in the death of Mr. Thomas Lowry. For, in spite of all his other various and absorbing activities, Mr. Lowry has maintained his membership in the Academy for nearly 36 years from almost its beginning in the spring of 1873. While, by his donations to our museum of the two fine specimens of Egyptian mummies, and by his keen interest in the welfare of the museum even during his late illness, Mr. Lowry has again only shown the bouyant interest and kindly helpfulness which has so remarkably characterized his breadth of mind and largeness of heart."

The paper of the evening, "The Future Timber Supply", was read by President T. B. Walker (printed in this bulletin) and discussed with much interest.

Winchell offered a resolution on Lincoln, suggesting calling the national schools of agriculture "Lincoln Schools of Science." Adopted, and the secretary was instructed to forward a copy to our representatives in congress.

Whereas, this meeting of the Minnesota Academy of Science takes place near the date of the one hundredth anniversary of the birth of Abraham Lincoln, and *whereas* it is suitable and incumbent on the American people, in gratitude for the great service and sacrifice rendered by him to the fundamental elements of American civilization, to perpetuate his name and to honor it by inscribing it in conspicuous places where the youth may frequently be reminded of the excellence of his character, and *whereas* the American Congress has by a commission appointed for this purpose, after long and extended consideration, recommended the construction of a great thoroughfare from Washington City to the battlefield of Gettysburg and, *whereas* still there seems to be room and opportunity to commemorate the name of Lincoln in a line of science in which he was a prominent actor, and:

Whereas it was by his signing and approving of the act of Congress in 1861 establishing the State schools known as Colleges of Agriculture and Mechanic Arts, to the maintenance of which this nation is committed, and which have since been called "National Schools of Science", of the United States, that the science of agriculture and mechanics have been benefitted and firmly established in the educational curricula of the country, therefore,

Resolved, that it is the opinion of the members of the Minnesota Academy of Science that the name of *Lincoln* ought to be applied by Congress to these schools, and that all the literature and all the researches from such schools that may hereafter be published ought to be labelled and every where known as products of the "Lincoln Schools of Science.

It is the opinion of this Academy that by so designating these schools, while an immaterial and uncostly honor would be conferred on the greatest American citizen, such honor would be likely to be more influential and more durable in the perpetuation of his memory than the expenditure of large sums of money in material monuments of any kind."

Minneapolis, Feb. 8, 1909.

The President nominated Winchell, Oestlund and Butler as a committee on nominations, which reported the renomination of the present officers. The Secretary was instructed by motion to cast the ballot for the following officers:—

President: T. B. Walker.

Vice President: F. W. Sardeson.

Cor. Sec'y.: O. W. Ostlund.

Rec. Sec'y.: H. Gale.

Treasurer: Edw. C. Gale.

Trustees for three years: C. W. Hall, H. Gale.

Curator Franzen reported that something would have to be done to preserve the group of orangs of the Philippine collection from destruction. Referred to the trustees. Moved and carried that the Secretary prepare a copy of the "Proceedings" for publication in a new bulletin and that the Academy publish such a bulletin as soon as possible. Adjourned at 9:40.

H. GALE, *Secretary.*

306th Meeting, Tuesday, March 2d, 1909, in the Museum Room.

About 12 persons present. In the absence of the President and Vice-President and no quorum of members being present, no formal meeting was held. But the announced subject of the evening, "The Psychology of Music", was given by the Secretary, Harlow Gale, showing in outline, with the aid of brain models, charts and some simple apparatus, the process of hearing through the ear mechanism, nerves, and brain; the perception of tones in pitch, quality, quantity and rhythm. Helmholtz and Dr. Billroth's "Wer ist musikalisch?" were much cited, and many original experiments given by the speaker.

Considerable discussion followed until after 10.

H. GALE, *Secretary.*

307*th Meeting, Monday, April* 5*th*, 1909, *in the Directors' Room of the Public Library.*

President Walker presiding; about 30 members and guests present.

"Personal Impressions of the Panama Canal" were given by Mr. Edw. C. Gale, illustrated by charts, maps, and photographs. The subject was continued by Professor C. W. Hall and gave rise to many interesting questions and much discusssion.

At 9:30 Professor Winchell explained the progress of the preparations for the A. A. A. S. meeting and the method of formation of the large committee of 100. Adjournment.

H. GALE, *Secretary.*

308*th Meeting, Monday May* 10*th*, 1909, *in the Directors' Room of the Public Library Building.*

No business. About 100 persons present to hear Dr. Thomas S. Robert's extremely able and interesting lecture on "Sparrows and Finches of Minnesota", illustrated from his own splendid collection of original photographs as lantern slides.

H. GALE, *Secretary.*

309*th Meeting, Tuesday Oct.* 5*th*, 1909, *in the Academy's Museum Room in the Public Library Building.*

In the absence of the President and Vice President the Rec. Sec'y., was called to the chair: about 20 persons present.

Report by Curator Franzen on the improvements in the Museum during the summer, the large increase in attendance, and the further needs.

Informal inspection of the eight new cases of Greek vases and glassware, Chinese idols, coins, a bison and a musk-ox head, and a mammoth tusk from Alaska,—all deposited in the museum by President Walker. Moved that the thanks of the Academy be given to President Walker for placing these valuable specimens in their handsome cases in the museum. Carried.

Symposium on the Cook-Peary discoveries of the North Pole; joined in by Norton, Child, Winchell, Oestlund, Wulling, Brown, Mackenzie, and Gale. The consensus of opinion was that Cook had gained in public confidence and Peary lost public sympathy by their respective conduct during the newspaper controversy.

H. GALE, *Secretary.*

On Monday afternoon, Oct. 25, 1909, from 3 to 4 o'clock, a Reception was given to Dr. Frederick A. Cook, the discover of the North Pole, in the Art Gallery of President T. B. Walker, 803 Hennepin Av. About 200 of the members and their friends were present.

Committee:

For the City of Minneapolis	*For the Minn. Academy of Science.*
B. F. Nelson	Prof. F. W. Sardeson
Willis Walker	Prof. C. W. Hall
F. M. Prince	Prof. N. H. Winchell
Dr. G. G. Eitel	Andrew Rinker
Dr. C. H. Hunter	Dr. T. S. Roberts
Judge D. F. Simpson	Dean F. J. Wulling
Miss Gratia Countryman	Dr. C. N. Spratt
	S. R. Child
	Edw. C. Gale

310*th Meeting, Tuesday Dec. 7th,* 1909, *in the Directors' Room of the Public Library.*

Vice President Sardeson in the chair: about 25 presnt.

Miss Mary C. Judd, 112 State St., was proposed for membership (by Winchell and Gale) and elected.

An extremely valuable and interesting paper was read from 8:15 to 9:15 by Mr. Warren Upham on "Englacial and Superglacial Drift in Minnesota, the Dakotas, and Manitoba." This paper gave the results of additional field work during the past summer and autumn, mostly near Winnipeg. Discussion till 9:45 by Sardeson, Moyer, Mackenzie, and Winchell. (Abstract in this bulletin).

Prof. Winchell spoke on the matter of delegates to the A. A. A. S. and by motion of the Academy was appointed the Academy delegate to the coming Boston meeting. Adjournment.

H. GALE, *Secretary.*

311*th Meeting, Tuesday Jan. 4th,* 1910, *in the Directors' Room of the Public Library.*

Annual Meeting. Vice-President Sardeson presiding; present,—Oestlund, Winchell, Norton, Franzen, Decker, Child, Miss Judd, H. Gale and six guests. Amendment of the By-Laws, offered by Wulling at the Nov. meeting, abolishing the membership fee of $5. and raising the yearly dues from $1. to $2., was adopted.

Curator Franzen spoke again of the necessity of sending for the Academy's collection of Philippine bird skins which had been several years with Mr. Bryan in Honolulu. After explanations from Winchell it was voted so to do.

Moved and carried that the chairman appoint a committee, not including any of the present officers, to present nominations for officers. Messrs. Child, Decker, and Norton were appointed. Moved and carried to postpone the election of officers to an adjourned meeting in one week, i. e., on Jan. 11th.

Cor. Sec'y. Oestlund reported 634 separate accessions to the Academy's Library during the past year. He enumerated many of the valuable exchanges and urged that some means be provided for making these valuable publications available for readers. Moved and carried to adopt his report and refer his recommendation to the trustees.

An extremely interesting paper on "Extinct Pleistocene Mammals of Minnesota" was read by Professor N. H. Winchell, and discussed by Sardeson and others. (Printed in this bulletin).

Much discussion of the past and future of the Academy until adjournment at 11.

H. GALE, *Secretary.*

312*th Meeting, Tuesday Jan.* 11*th*, 1910, *in the Museum Room.*

Vice President Sardeson presiding: 10 members present.

The chairman spoke of the condition of the Academy.

Report of the nominating committee from the last meeting was received and read. Moved by Winchell and seconded by Rinker that the Secretary cast the ballot of the Academy for the officers reported by the committee. Carried and done, resulting as follows:

President: T. B. Walker.

Vice President: F. J. Wulling.

Treasurer: Edw. C. Gale.

Cor. Sec'y.: O. W. Oestlund.

Rec. Sec'y.: H. Gale.

Trustees for three years: O. W. Oestlund and F. W. Sardeson.

A letter from Prof. Washburn was read, inviting the Academy to send representatives to a meeting at Pres. Northrop's house to arrange for the meeting of the A. A. A. S., which had accepted the invitation from Minneapolis in the name of President Northrop. Vice President Wulling and Prof. Winchell were appointed delegates from the Academy. Much discussion as to this invitation and the original one a year ago from President Walker and a score of other organizations; whether St. Paul joined in it and should be asked to participate in the reception committee. Finally moved and carried that the secretary be instructed to answer Prof. Washburn's letter and remind him of the list of persons and institutions joining in the original invitation.

Moved that the matter of abolishing the $5 membership fee be reconsidered and a committee of three be appointed to consider and report on it. Carried. Chair appointed Winchell, Oestlund, and H. Gale. Moved to reconsider the question of annual dues and that they be raised from $2 as voted at the last meeting, to $3. Much discussion. Carried. Adjournment about 10.

H. GALE, *Secretary.*

313*th Meeting, Tuesday Feb. 6th*, 1910, *In the Museum Room.*

Vice President Wulling presiding: 7 members and 15 guests present.

Informal report by Winchell of the committee meeting at President Northrop's house to prepare for the meeting of the A. A. A. S.; also of the various amendments to the Academy's constitution, as found by him in the office of the Minnesota Secretary of State. Moved and carried that the various amendments to the Academy's constitution be properly collected and recorded with the Secretary of State by Childs and Gale.

Moved and carried that Curator J. W. Franzen be elected a member and that his membership fee and all dues be remitted in consideration of his services.

In "The Continental Ice-Sheet a Myth?" Mr. H. B. Norton made an effective array of the evidence against the Glacial Theory as the sole cause of our drift, illustrated by many geological specimens and photographs. Much discussion followed by Winchell and others. Adjournment at 10.

H. GALE, *Secretary.*

314*th Meeting, Tuesday March* 8, 1910, *in the Directors' Room.*

Vice President Wulling presiding: about 40 persons present.

An extremely able paper "On the Structure of the Universe, being a presentation of Professor Osborne Reynolds' Theory of Gravitation" illustrated by experiments, was given by Mr. John Mackenzie, M. E. E.

This learned paper was followed by much discussion by Profs. John and Anthony Zeleny, and others. (Printed in this bulletin).

H. GALE, *Secretary.*

315*th Meeting, Tuesday April* 5, 1910, *in the Directors' Room of the Public Library.*

Vice President Wulling presiding: about 25 present.

A report on "Teaching Bacteriology in a City High School" was given by Miss Eliz. Foss, of the North High School.

A paper on "The Minneapolis Wild Botanic Garden" was given by Miss Eloise Butler, of the South High School, illustrated by lantern slide photographs of this Glenwood garden, founded by Miss Butler, and of its use in High School education.

H. GALE, *Secretary.*

316*th Meeting, Tuesday, May 3rd*, 1910, *in the Directors' Room.*

Vice President Wulling presiding: about 70 persons present.

A paper on "The Prairie Legumes of Western Minnesota" was read by Mr. L. R. Moyer of Montevidio, Minn. (Published in this bulletin.)

A lecture on "Halley's Comet," illustrated by many lantern slide photographs of this and other historic comets, was given by Professor F. P. Leavenworth, of the University of Minnesota.

H. GALE, *Secretary.*

317*th Meeting, Tuesday, June 7th*, 1910, *in the Directors' Room.*

Vice President Wulling presiding: about 15 present.

An address on "The Kinds of Reasoning and the Psychological Evidence for and against the Existence of 'Souls' and 'Spirits' " was given by Mr. Harlow Gale.

Much discussion until adjournment at nearly 11 o'clock.

H. GALE, *Secretary.*

CONSERVATION OF THE FUTURE LUMBER SUPPLY.

By President T. B. Walker.

Any practical plan of conservation of existing forests for a continued future supply of lumber and wood products must be based upon a fair, candid understanding of past conditions and policies which have been responsible for the wasting and denuding in the past.

Investigations should not be confined to summarizing present conditions. They should be directed largely to determining the causes which have been responsible for denuding our forests. In this way only can past errors be avoided and a comprehensive plan be worked out to conserve the future supply.

The destruction of our forests is charged to the wasteful propensities of our lumbermen. This is as unjust as it would be to charge the agriculturalists with a responsibility and blame for destroying our hardwood forests.

These forests were two to three times as extensive in area and amount of timber as the pine or coniferous forests. To reach the soil to furnish the food supply the timber was rightfully and naturally cut away, and in large part destroyed by burning—only a fractional part being utilized.

So far as the forestry questions relate to hardwood timberland, which was mostly agricultural, the conveyance of title, largely as a free gift under the Homestead Act was not only justifiable, but a necessary policy to pursue. While it resulted in the destruction and waste of a large proportion of the hardwood timber, it cleared the land and laid the foundation for the great national progress and the prosperous conditions now existing.

The lumbermen, being as legitimately, and next in usefulness to the farmer engaged in furnishing the timber supply, were naturally compelled to cut and manufacture the pine forests in a way which would make a return for the labor, capital and energy devoted to it. The farmers have always had the good will of the people, but for some remote and contingent reasons, a strong prejudice has existed against the lumbermen.

The policy of distributing the pine timberlands as a gift or at a nominal price to the multitude of people or citizens who chose to secure a tract for the advantages of the speculative value, was not a wise or justifiable policy.

But as the present timber and stone act has been preceded by yet more liberal laws, by which distribution of the timberlands was made from the earliest times and applied to all the forests from the eastern states all across to the remaining western states, the western people naturally consider that the same right and privilege should be continued with them, and there is so little left unreserved or not disposed of that it makes but little difference at this late day.

The timber land should not have been sold in this way. The timber should have gone direct in suitably large tracts, to those who intended to hold and use it in supplying the public demand for lumber. This would have been more appropriate and served better purpose for the public. It was the intention that this method of disposing of the timber should be only an indirect way of furnishing the lumberman with timber from which to supply the public with the necessary commodity of lumber.

This roundabout method made higher costs of stumpage and heavier carrying charges of interest and taxes, and also prohibited securing consolidated holdings and cheaper logging and driving.

It originated more from a prejudice against a presumed monopoly which was anticipated if the timber was placed directly in the ownership of lumber manufacturers at a minimum price and in large consolidated holdings. These facts have also been emphasized by the refusal to give to lumber a tariff approximating that given to other products, although, in this case, the foreign competitors had greater advantages in supplying our market at much lower prices than other manufacturers had to contend with.

This to a considerable extent, has come from the policy of the government in its determined efforts to depress and keep down to the lowest possible point the price of the lumber to supply the needs of the public.

One important feature of the government policy accomplished or operated in the opposite direction and tended to increase prices.

It has from the start been made a criminal offense for the lumber manufacturers to seek to secure a large body of pine at a low cost, which made the production of lumber more expensive. This, added to the high rate of wages, the carrying charges of interest on the larger investments and the excessive taxation on standing timber, lumber, mills, etc., has compelled the rapid destruction and the wasteful methods of producing lumber.

It has been one strong feature of the government policy to survey the forest lands rapidly and place them in market in order to keep an over-stock of timber, with a view of cheapening lumber for use of the public. This policy has resulted in the surveying of over nine-tenths of the timber lands, and leaving in the possession of the government less than ten per cent of the original area and quantity of timber. the government owning a considerable amount of land that is surveyed, together with some that is yet unsurved.

This method of disposing of the timber has made the cost of the timber to the lumbermen or timber owners much higher than the price received by the government from the entrymen, and has been one of the prime factors in the denuding of the forests. And the method of disposing of the timber has prevented the lumbermen from securing consolidated holdings by and through which they could, to better advantage, conserve and preserve the forests.

These conditions have prevailed, to a large extent, from the earliest times through the territory of our white pine forests to within the past ten or fifteen years. They do now and will prevail in the future in the remaining quite extensive southern forests, and the great and principal supply of the Pacific or western states. In the old white pine states the problems of conservation are of little concern. The small stock of timber remaining and the reduced amount of the white pine in the eastern Canadian provinces, render it of much less concern as to the remainder of our white pine forests. On the Pacific coast the conditions are as much subject to waste as those formerly prevailing in the old pine regions; and in some respects more waste has been carried on, especially in the great forest of California.

We are now confronted with the conditions and problems transmitted to the remaining timber supply and which have led to the consumption and the wasting of so much of our forests that there is now left only an equal fraction of the original timber supply. The temporary advanced prices of lumber in the central and eastern part of the country, excepting as to the past year when prices have been lower, has not, to any extent, reduced the per capita use of lumber, or the general consumption which has prevailed in earlier years. In fact, for the past several years, the per capita consumption has been increasing because of the disappearance of the hardwood which formerly supplemented largely the pine lumber, but which is, to large extent, now exhausted. The use of lumber within the past several years has reached the actual amount of nearly 600 feet per capita, although counted at only 500, as a large amount is cut that is not reported. The use of substitutes like cement, iron, steel, bricks, stone or paper for purposes where lumber was formerly used, has not apparently reduced the demand materially. The great activity has kept the demand and supply up to the former amount.

The inherited conditions pertaining to the remaining forests bring with them the same difficulties for the continuance of forest destruction that have caused waste in the past.

Unless a more correct and rational understanding of the lumber situation and problems is taken and understood, rightly appreciated, and a practical policy—with public sentiment fairer to the lumbermen—more adaptable to the real best interests of the public, is put into operation, a comparatively few years will see the end of cheap or moderate priced lumber.

This desire to over-stock the market with the timber supply has been carried to that extent that while we have been cutting over and denuding one-half of our coniferous forests, the title to nearly the whole has been parted with by the government. So that at the present time, the condition is that about one-half of our pine timber lands have been denuded. Of the other half over four-fifths of this remainder has been sold under this promiscuous method and passed to private owners.

The conservation of the forests under, and in the manner that the lands have been handled by the government, and other adverse conditions, have made it absolutely impossible for the lumbermen to cut and handle the timber conservatively, or to reforest the areas as they were cut over. In fact, the lumberman has had more adverse conditions to work against than the men engaged in any other industry or occupation whatsoever.

We have now reached that period of our history when it has come to be known that the forests must be conserved or in a comparatively few years, supply will be practically exhausted.

Other substitutes, and economical and more efficient methods of manufacture, can and will be applied when the price of lumber gets to that point that it will make practicable these new methods. But in the meantime the remaining forests, especially those in the Pacific and mountain states where the land is of but litle or no use for agriculture and available for a timber supply, and where the area is sufficient to furnish a reasonable stock for many generations to come—perhaps a perpetual supply—may be sufficient to serve the more urgent needs of the people, and especially when supplemented by the general development of timber culture throughout the countrl.

The question now comes up—what can be done to conserve the forests?

There is quite a demand for the removal of the little tariff protection that is now existing. Agricultural products are protected to an extent three times as great as lumber, which are not in need of protection to as great extent as lumber; and it would not work continued waste by removing tariff on agricultural products as it would on lumber.

The forests will be continually wasted as a matter of necessity if free lumber and continued high local taxes are maintained.

The timber lands are held in such small parcels or tracts as to make conservative methods of lumbering, together with reforesting and the protection of timber from destruction by fire, impracticable. At all events, the timber lands must be consolidated to make conservation a possibility.

So that under existing conditions, I do not see but one practicable plan to conserve the present forests and provide for a future supply.

Economical lumbering can be carried on only on a large scale with sufficient capital and large enough operations to establish large milling plants and provide them with a stock of timber that will, for the first cutting, extend over nearly or quite a century before it is once cut over. Then to apply thoroughly efficient measures for reforesting as the land is cut over, and to protect the whole tract from destruction or damage by fire.

This handling of the forests, the reforesting, the economical cutting and manufacturing in ways that will make a cost for the low grades more than their worth now in the market, must necessarily be provided for, and a tariff sufficient on the low grades of lumber with which we cannot compete and conserve the forests.

In cutting the timber, it will be necessary to leave the smaller size trees up to those of medium size. These will necessarily have to be a continual source of expense in reforesting and protecting and interest on the investment. The cost of logging and manufacturing, and especially if the more conservative methods of producing composition boards of a thinner kind, are entered upon, will make the cost of production higher, but will increase the amount of available lumber to the extent of two or three times what the old methods or even more conservative way of applying the old sawing methods.

Then the question of local taxation must be met and the matter of taxing the one crop of timber every year for a century on the same crop, must be radically changed and the standing crop of timber must not be taxed, but a reasonable tax on stumpage may be placed on the timber when cut for the benefit particularly of the local county in which the timber is located, and which tax should be paid to the county for any amount cut in that county whether manufactured there or elsewhere. All other taxation on the lumber cut and other taxation pertaining to the lumber production should be merged into this stumpage tax, which may be made to perpetually furnish the country a larger revenue than under the old method, but in such way that it can be charged up as part of the cost of the timber. And with this change in taxation a better method of organizing timber and lumber companies should be enforced in such way and under such provisions of organization and management and control, that the government and the public will be satisfied that it is not a trust form organized to plunder the people by means of extravagant prices. It is evident that higher prices for lumber, more especially on the lower brades, but in general on the whole mill run, must be maintained in order to make it practicable, or we might say possible, to conserve the timber, and which for the next perhaps ten or fifteen years would make lumber moderately higher priced than at present, but not excessive compared to other commodities and products. And at the end of 20 or 30 years, this process, if the whole or a large part of the remaining forests could be placed in such aggregations and under the best practicable form, the prices of lumber for the next 30 to 50 years would probably not be one-half of what they will be without a practical process of this kind.

A tract of timber of say 250,000 acres of the heavy timber of the coast would furnish a stock sufficient to furnish a hundred million a year of lumber for a century, or nearly that. By reforesting and protection to the fullest extent, there will, at the end of that time, be timber standing, that when cut over from the same point of beginning as was practiced the previous century, that before it is cut over the second time will produce for this second cutting as much, or more lumber, than was taken off the first cutting, and at the same time leaving a sufficient re-foresting stock to make for the third century perhaps as large a supply.

The lumbermen generally are willing to do their full part in any practical scheme or measure that will enable them to handle the timber in the most conservative method practicable for them to devise if the conditions are made so that they can do it. But if free trade, designed to cheapen lumber, excessive taxation and prejudice against large timber holdings, shall prevail, it cannot be accomplished.

To organize companies to handle the timber in such a conservative method as herein outlined, it would seem to be necessary for Congress to enact laws under which might be organized companies of that nature and kind that would meet the approval of all parties concerned, including capitalists, timber owners, counties, states and the general government and public. Such act of Congress should provide for the method of organizing the companies, the issuance of stocks and bonds and stockholders' liability, and for a sufficient supervision and control by the government through the Commission and Forestry Departments so as to protect from fire, and conservation methods of cutting and manuracturing, and in reforesting, and against excessive prices on lumber which might result from controlling a large part of the supply of lumber, but provide and authorize a sufficient price to make it practicable and reasonably profitable to so handle and conserve the timber.

There may be same other methods of doing it. I do not know what way would be practicable, excepting in this general way. It is certain that small holdings cannot do any more than cut the timber into lumber as rapidly as possible, as they have in the past, and cut and handle the timber in the cheapest way of producing the lumber, and produce only the kind and quality of lumber that will bring a price large enough to make it profitable. In other words, the continuance in large part of that system which has prevailed in the past and has wasted the forests, and will continue to do so without doubt or question if present conditions are continued.

The Conservation Commission has made no suggestions other than a resolution asking the States to take a certain supervision of the methods of cutting timber, but which, when applied to the best that the State can do, will not be sufficient means for conservation to provide for a future supply of lumber.

The time is becoming shorter when any feasible conservation plan can be developed and installed in time to save enough of the forests to make anything of a reasonable supply for the future at reasonable costs or prices. The message of the Governor of Washington to the Legislature just now handed in says that conservation must be entered upon immediately. That in ten years from now it may be too late. And I will say that it is a matter more particularly for the general interests of the Commonwealth than it is for the timber land owners.

But the timberland owners are willing to adjust themselves to a reasonable method of handling the forests on that basis that will bring about the best results for the future welfare of the whole nation along any lines that will not be unjust, unfair and destructive to the interests of the present owners who came into possession through the voluntary established laws and public policy of the nation.

The timber land owners do, or should, recognize the fact that the timber is the heritage of the people; Providence provided it for the benefit and use of the people generally.

The soil was made fertile and to serve the essential purpose of furnishing the food supply of all the people, and not for the exclusive benefit of those engaged in agriculture; but the distribution of the farming lands was made upon the same general policy of so distributing the earth's surface among those who chose to enter upon that occupation that it would, to best advantage, supply the whole Commonwealth with food the same as the distribution of timber would furnish the lumber supply.

There is complaint of the agricultural methods as there is of lumber, and the agricultural lands are brought in as one of the essential measures where conservation is considered necessary to protect the general interests of all, the same as with the timber.

And while the farmers are doubtless equally under obligations to handle the soil conservatively and bring it to the best use of all as well as of themselves, the lumbermen do, or should, recognize that they are equally under obligations; but in both cases, the public can only expect, and put in force, any policy or requirement consistent with the ownership and local control of each tract or portion which has come into the possession of the different individuals or companies—whether of timber or agricultural land.

That the timber should be conserved in the best practical manner, and the soil cultivated in a like conservative way to produce the best results in both cases, is the duty of both the farmer and the lumberman, as far as it is made practicable for them.

But the General Government, the States and timbered Counties and the timberland owners and lumbermen must co-operate and agree upon a conservation policy that will to best advantage for the future and for centuries to come, serve the best interests of the present and coming generations with the best and most satisfactory supply of timber that can be devised to meet the increasing demands of the great populations of the future centuries.

THE PRAIRIE FLORA OF SOUTHWESTERN MINNESOTA.

L. R. Moyer, Montevideo.

In its physical features western Minnesota is an undulating plain lying about 1,000 feet above the ocean level. This plain is of glacial origin, and consists of blue and yellow till, probably underlaid with beds of Cretaceous rock. Entering the state about thirty miles south of Big Stone lake and extending southeasterly toward the southern boundary of the state is a great terminal moraine known to the early voyageurs as hte "Cateau des Prairies." In the western part of Lincoln county the Coteau rises to the hight of about 1,900 feet. The northeasterly slope of the Coteau consists of till containing many boulders—worn and rounded by the glacial waters. Some of these boulders are of granitic rocks similar to the rocks in the northern part of the state, and others are of magnesian limestone—such as are not now found in place nearer than at Winnipeg.

Another terminal moraine known to geologists as the "Dovre moraine" extends from a point in Kandiyohi county north of Willmar, northwesterly through Swift, Pope and Douglas counties, and culminates in the Leaf hills in the southern part of Otter Tail county, where an elevation of 1,750 feet is reached.

Between the Leaf hills on the north and the summit of the Coteau des Prairies on the south lies the Minnesota valley. This valley in western Minnesota has a width of about 120 miles; and through the center of this region the Minnesota river—or more properly the glacial river which preceded it—has eroded a deep channel, cutting through the drift, and through the geologically recent rocks on which the drift is super-imposed, down to the original Archean rocks which appear to cross the state from the northeast to the southwest. These rocks are exposed in great ledges at Beaver Falls, Granite Falls, Montevidio, and Ortonville. This river bed or channel is from 100 to 200 feet in depth and will average about one mile in width. In many places the bluffs are quite abrupt, and in other places they have become much worn down. A great river once occupied this valley extending across from bluff to bluff, and was the outlet of a great lake which covered all the Red River country. This great lake is known to geologists as Lake Agassiz and the ancient river has received the name of the River Warren. The Minnesota river which now occupies this great channel is a typical prairie river. In midsummer when it is dry, and likewise in winter when its affluents are frozen up it is an insignificant stream; but when a heavy snowfall melts in April with unusually heavy spring rains it is still capable of becoming a great stream sweeping everything before it.

From the south the Minnesota river receives such important affluents as the Redwood river, the Yellow Medicine river, the Lac qui Parle river, the Yellow Bank river, and the Whetstone river. All of these streams head in the Choteau des Prairies and in the case of sudden rains send down from their headwaters enormous floods. From the north the Minnesota receives Hawk creek which heads in the hills north of Willmar, and the Chippewa and Pomme de Terre rivers which both head in the Leaf hills.

The soil o fthis region is mostly a deep black loam—formed from the materials brought from the north by the glaciers, containing for the most part decomposed limestone, and is very rich and fertile. There are some sandy areas, apparently formed from the till by the water that flowed away from the melting ice. There are areas—more or less large—of loess, or wind-formed soil.

With the exception of narrow strips along the streams or on the north slopes of protected bluffs, or in ravines, such as the couleés cut by streams in the slopes of the Coteau, the region under consideration is all prairie.

Much of this region was at one time timbered, and it is not uncommon to find well preserved trees deeply buried in the drift. Such a tree was found in digging a well at Montevideo, in the bluff near the south end of Fifth street, some 20 feet below the surface. The tree was probably a pine, carried there by the last extension of the glaciers. It seems likely that the reason for the treeless condition of much of this region is due to diminished rainfall. At Montevideo the average annual rainfall is 21.33 inches. This rainfall is sufficient to produce a thrifty growth of trees in the deep rich alluvial soil of the river valleys, but seems to be insufficient to induce a successful stand of trees on a closely compacted soil of heavy till without cultivation. It has been thought too that the rainfall is too unequally distributed through the year,—sufficient perhaps in the summer, but deficient in the inter. Others have suggested that the hot southwest winds from the plains scorch and wither the trees and make the forest impossible. Many think, and with much show of reason that the treeless condition of the prairies is due to prairie fires set by man. Prof. Shaler has advanced the idea that the American Indians before the advent of the whintes had advanced to such a degree of culture that they had begun to regard the great herds of bison then living on the prairies somewhat in the light of domestic animals, and that they purposely set fire to the prairie and forest openings to make better pasturage for them.

Among the trees native to this region and forming the great body of the native forests are the following:

American elm (Ulmus americana).
Green ash (Fraxinus lanceolata or pennsylvanica).
Bur oak (Quercus macrocarpa).
Box elder (Acer Negundo).
Cottonwood (Populus deltoides).
Basswood (Tilia americana).
Slippery elm (Ulmus fulva).
Silver maple (Acer sacharinum).
Cork elm (Ulmus racemosa).

Hackberry (Celtis occidentalis).
Ironwood (Ostrya virginiana)..
Willow (Salix amygdaloides).
Red) cedar (Juniperus Virginiana).

Along the borders of the forest may be found such shrubs as:
Wild plum (Prunus americana).
Wild red cherry (Prunus pennsylvanica).
Choke cherry (Prunus virginiana).
Sheepberry (Viburnum lentago).
Downy arrow wood (Viburnum pubescens).
Burning bush (Euonymus atropurpureus).
Red osier dogwood (Cornus stolonifera, or more properly perhaps stolonifera riparia of Rydberg).
June berry (Amelanchier oblongifolia).
Smooth rose (Rosa blanda).
Hawthorne (Crataegus Sp.)
Shining willow (Salix lucida).
Heart leaved willow (Salix cordata).
Sandbar willow (Salix longifolia).
Buffalo berry (Shepherdia argentea).
Wolf berry (Symphoricarpos occidentalis and S. orbiculatus).

Nearly all of these shrubs and trees have an eastern range and they appear to be advancing westward. The Buffalo berry is the only one of them that seems to have come from the west, and that seems only to be found at the head of Big tSone lake. Where the woodlands are not heavily pastured the forest seems to be advancing on the prairie. This advance is led by the shrubs, especially by the Wolf berry. In small valleys and wherever the soil is uneven the Wolf berry springs up, forming a dense shade, and destroys the tough prairie sod. Under the shelter of its leaves sunflowers, silphiums and other tall Compositae spring up, to be followed by box elders, green ash, bur oaks and other forest trees. On low bottoms the sand bar willow answers the same ends, forming dense patches on the river bottoms to be followed by box elders, ash and elms. On other and higher prairies the borders of the forest are extended through the growth of shrubs, such as the wild rose, wahoo, choke cherries and wild plums. As soon as the shrubs have taken possession of the ground the seeds of trees spring up amongst them and the forest is extended.

The black walnut is found as far west as Walnut Grove in Cottonwood county. There is a grove of sugar maples in what is known as the Lynn woods on the headwaters of the Redwood river, where it descends from the Coteau southwest of Marshall; and there is another grove of the same tree where lake Whipple lies embosomed in the Dovre moraine at Glenwood in Pope county. There is also said to be a grove of sugar maples in the ravine formed by the Minnesota river, where it cuts through the coteau in South Dakota.

When we turn to the prairie flora of this region, we are beset with many difficulties. In the first place the prairie flora has been destroyed. The breaking plow has been at work in this region for about forty years, extending the wheat fields, and the remaining portions of the prairie have been fenced in by barb wire fences and closely pastured. The showy prairie flowers are gone, and even the grasses have been mostly destroyed. Along the roadsides and on railway rights of way a few individuals of the original flora are still to be found, but they are being rapidly driven out by the introduced blue grass and by European weeds.

No ecological survey of this region conducted according to modern ecological methods, has ever been made, and it does not seem possible to make such a survey now. It may however be best to put on record some notes regarding this flora, based partly on recollection and partly on herbarium material. The writer greatly regrets that he feels incompetent to write accurately about the most important constituents of this flora—the prairie grasses.

For convenience this flora may be considered in different groups or areas characterized somewhat as follows:

1. The upland prairie flora, found on high rich rolling well drained land.
2. The slough or marsh flora on land covered by water, or at least wet for the greater part of the year.
3. The prairie meadow flora usually a zone area around a marsh, or rich low lands between low hills.
4. The alkali flora on low saline level prairies where vegetable growth is much stunted.
5. The valley flora where there is good drainage but plenty of moisture.
6. The bluff flora where the soil is dry, and where xerophytic plants abound.
7. The rock flora on gneiss or granitic rocks and on the surrounding shallow soil where the conditions are still more xerophytic.
8. The bog flora found around prairie springs.

Let us consider these floras, or different plant societies, somewhat in detail.

1. *The High Rolling Prairie Flora.*

The greater part of this region consists of high rolling prairies. These are now all under cultivation, so that the characteristic prairie plants are destroyed. These notes refer to what the observant traveler might have seen thirty years ago. With the opening of spring the first plant to attract the attention of the traveler would doubtless have been the pasque flower, Pulsatilla hirsutissima as we have been in the habit of calling it, or *Anemone potens wolfgangia*, if we are bound by the Vienna agreement. It opens its pale lilac petals early in April on dry ground everywhere, and is almost equally conspicuous later on in its fruiting stage when it flings to the breeze its silvery silken styles. *Ranunculus rhomboideus* is found opening its golden petals low down among the gray grasses of the previous year. At about the same time of the year the diminutive *Carex pennsylvanica* is seen blooming everywhere. It is in May, too, that the holy grass, *Hierochloe odorata*, earliest of grasses, sends up its sweet scented panicle in little depressions of the prairie. The deep purple flowers of the prairie violet, *Viola pedatifida*, now begin to appear on the hills. The yellow flowers of the star grass, *Hyproxis hirsuta*, brighten up the springing grass. The prairie blue-eyed grass, *Sisyrinchium campestre*, blooms with the star grass, and many of the plants show white flowers. In dry places the earliest of the Compositae, *Antennaria plantaginifolia*, forms patches of gray on the prairie. Toward the end of May the early meadow rue, *Thalictrum dioicum*, opens its delicate blossoms on rich ground. *Viola pratincola* opens its modest flowers, but buries its cleistogamous flowers in the ground. The ground plum, *Astragalus caryocarpus*, opens its showy racemes of violet-purple flowers, to be followed by its thick-walled fleshy edible pods, said to be part of the bill of fare of the early voyageur. *Vicia americana* is common in rich places, and *Vicia linearis* could be sometimes found toward the western boundary of the state.

With the beginning of June several grasses become conspicuous, and among these perhaps the most common and beautiful are the pale panicles of *Koeleria cristata*, opening everywhere on bluff side and prairie. A much taller and almost equally beautiful grass is *Phalaris arundinacea* often found in moist places on the prairie. The slender wheat grass, *Agropyron tenerum*, is seen sending up its slender spikes everywhere. This grass has persisted along road sides and on dry bluffs, and has perhaps the most agricultural value of any of the native grasses. On richer and moister prairies the awned wheat grass, *Agropyron caninum*, is found sending up its nodding bearded spikes, while in very dry places the western wheat grass, *Agropyron smithii* is common, and its broad flattened spikes are very conspicuous.

Sometimes, but not very often, *Comandra umbellata* is found forming patches on the prairie early in June, where its long running root stocks seem to connect the plants together..

On high rolling prairies *Psoralea esculenta* sends up its spreading bushy tops villous with whitish hairs, bearing spikes of bluish flowers. This plant has a deep farinaceous root and was called "pomme-de-terre" by the French frontiersmen, and it was from the abundance of this plant along its sandy banks that the Pomme-de-Terre river took its name. By the Sioux Indians, this plant was called the Teepsenee, and it was their principal food plant. One who chose to follow an Indian trail in the early days was sure to find wherever the Indians camped a great pile of these thickened roots from which the edible central part had been extracted. These roots are rich in starch and have a pleasant flavor. I do not know that any attempt has ever been made to cultivate this plant. Perhaps it would take too many years to get a crop. In shallow depressions of the prairie one is sure to find a rich growth of *Lathyrus venosus* with its showy bluish or purple flowers. In early June, too, the prairie rose, *Rosa pratincola*, begins to bloom; and one who has seen it at its best will never be able to forget its beauty. Toward autumn, the corymed flowers are followed by the large showy, glabrous fruits which distinguish it from the smaller fruited smooth stemmed rose, supposed to be *Rosa blanda*, found along the river banks and edges of timber. The proper nomenclature of these two roses would be much easier did we not find many bushes seemingly intermediate between the two. Another prairie shrub, *Amorpha nana*, blooms early in June; and its long slender curving spikes of deep purple flowers are very beautiful. *Amorpha canescens*, almost always called shoe strings for the reason that its roots are so hard to cut with a breaking plow, blooms a little later. Its flowers are not nearly so showy, while its densely canescent foliage serves largely to give the prairies their prevailing gray tint. Two species of *Lepidium* are in bloom by road sides and on waste ground. By the middle of June, the red flowers of *Phlox pilosa* are to be seen everywhere, while the marsh vetchling, *Lathyrus palustris*, is blooming in low rich places. The vetches are especially common about gopher mounds. Towards the close of June, the silvery-white foliage of *Psoralia argophylla* begins to be dotted with its deep purple flowers. Among the rarer June flowers is *Agoseris glauca*, a plant of western range, observed in Big Stone county.

Early in July the grayness of the prairie due to the *Amorphas* and *Psoraleas* is heightened by the whitening glumes of the ripening porcupine grass, *Stipa sparatea*. The loosening seed grains with their long spiral awns work through one's clothing and irritate one's flesh in a way never to be forgotten. The Canada milk vetch, *Astragalus canadensis*, becomes a conspicuous object on the prairie where the soil has been loosened by the pocket gopher. Where the soil is somewhat moist the whitely tomentose showy milk weed, *Asclepias speciosa*, raises its stout stem thickly covered with its large oval leaves, carrying at its top its clustered umbels of large flowers. In dry places the rough ox-eye, *Heliopsis scabra*, begins to bloom,—a forerunner of the great show of Compositae to follow. In rich places the showy tick-trefoil, *Desmodium canadense*, may be seen in bloom, together with two prairie clovers, *Petalostemon purpureum*, the latter being one of our most showy prairie flowers. The tall *Elymus canadensis* with its nodding head is now one of the most notable of prairie grasses and the field thistle, *Cirsium discolor*, is becoming a conspicuous object everywhere. Its flowers are light purple or pink, while its stems and the under sides of its leaves are densely white tomentose. Occasionally one finds a white-flowered plant. *Scutellaria parvula* is a modest and unassuming plant on level ground, while *Chenopodium album* grows up in waste places.

In the early part of August the tall stems and purple spikes of the big blue stem grass, *Andropogon furcatus*, are conspicuous objects on rich moist prairies. Indeed, one who has seen this noble grass in great areas growing on the wild prairie, especially if he has seen it in full bloom in early morning swaying before a gentle south wind, will have impressed on his mind a sight never to be forgotten. This grass was the blue stem of the early settlers, and the hay made from it was more prized than that of any other grass. In these rich upland meadows there is sometimes found the tall meadow rue, *Thalictrum purpurascens*, always a conspicuous object. On rich soil the great rag weed, *Ambrosia trifida*, grew to immense proportions, often forming thickets where horses and rider might be concealed from view; while the common rag weed, *Ambrosia artemisiaefolia* was found on the prairie everywhere. Both of these rag weeds became pernicious weeds, after the cultivation of the prairies began, and grew much larger on cultivated ground. The rough cinque foil, *Potentilla monspeliensis*, is occasionally found on the prairies, but is not so common as in the older parts of our country. *Convolvulus sempium* grows around gopher mounds and climbs over *Symphoricarpos*. Since the cultivation of the country began it has become common in fields. In dry places, *Eragrostis purshii* often forms a considerable portion of the soil cover, spreading like a mat over the ground. *Gerardia tenuifolia*, another August flower, is common on bluffs and frequent on level prairie. The earliest sunflower to bloom is *Helianthus scaberrimus*, common on prairies, and persistent as a weed in wheat fields. It is commonly called rosin-weed. Closely related to the rag weeds but with broad entire leaves is *Ivaxanthifolia* growing to the height of six or seven feet in rich locations, and becoming a pernicious weed after the cultivation of the prairie began. The early smooth golden rod has been called *Solidago Missouriensis*, but it is clearly different from *Solidago Missouriensis*, as it grows on the foot hills of the Rockies, and Dr. Rydberg is of the opinion that it should be referred to *Solidago glaberrima* of Martens. *Solidago serotina* is common in moist places, and on the borders of meadows grows to immense proportions. Late in August *Solidago nemoralis* is found in dry places, and is readily identified by its one-sided panicles. Another autumnal golden rod is *Solidago rigida*, probably the most common of them all, persisting in old pastures. Perhaps *Solidago canadensis* is equally common. In some of its forms it seems to be the variety *gilvocanescens* of Rydberg. Another August plant is the wild liquorice, *Glycyrrhiza lepidota*. Its yellowish flowers open in July, but its brown seed pods with glandular prickles make it more noticeable in August. No use is made of it for its medicinal properties. In taste the root resembles the liquorice of commerce, but it is more bitter. Among the tall August grasses may be noted *Panicum virgatum*, *Sorghastrum nutans*, and *Bromus kalmii*. The varieties or species of *Physalis* found on the prairies in August are of difficult limitation. Some seem to be *Physalis longifolia*, of Nuttall, some approach *Physalis lanceolata*, of Micheaux, and others are clearly *Physalis virginiana* of Miller. *Amaranthus blitoides* and *Amarantus graecizans* are common in waste places, especially on new breaking. The latter forms a bushy clump, and in autumn breaks loose at the root and goes bounding across the prairie before the wind. The Russian thistle, *Salsola tragus*, is becoming a common weed in similar locations and shows the same tendency to become a tumble weed. It is uncertain whether or not the common purslane, *Portulaca oleracea*, was a native of this region; but it is frequently found in such locations as to suggest that it was here before the advent of white men. The evening primrose is a common August flower and may be called either *Onagra strigosa* or *Oenothera strigosa*, but the plant needs more study. A small prostrate spurge, probably *Euphorbia glyptosperma*, is a common plant on wild prairie, but more noticeable on new breaking. The prairie dock, *Rumex mexicanus*, is most common on moist ground. Among the grasses of late summer may be noted *Muhlenbergia racemosa* and *Eragostis major*. The latter is common in gardens and on cultivated ground.

A stately plant of early autumn is *Pernathes racemosus*, growing on rich ground, sometimes to the height of six feet. The only gentian common on the autumnal prairie is the *Gentiana puberula*, and it opens its blue flowers very late, sometimes blooming even in October, when the prairie grasses have taken on the brown tints due to frosts. The prairie is now whitened with *Aster multiflorus* and its allies. It is easy to find plants which may be called *Aster exiguus*, (Fernald) Rydberg, and on the plains of South Dakota are plenty of forms that may be called *Aster comutatus*, of Torrey & Gray. However there seems to be so many connecting forms that it seems about as well to call the whole group *Aster multiflorus*.

2. *The Slough Flora.*

Perhaps the earliest spring flowering plants of the prairie sloughs and marshes are the water crowfoots. When the water is low *Ranunculus delphinifolius* is found blooming in muddy places in the latter part of May, or if the water is high, it will be found a little later blooming in the water itself. *Ranunculus abortivus* is found in moist places at about the same time, and *Ranunculus sceleratus* soon follows. In deep sloughs and in the still waters of rivers *Ranunculus circinatus* and *Ranunculus aquatilis* are seen showing their white flowers in June. An *Eleocharis* which seems to be *E. palustris glaucescens* may be seen growing in shallow water or in wet places early in June. *Scirpus fluviatilis* and *Scirpus polyphyllus*, together with *Juncus nodosus*, *Juncus lurida*, *Carex festucacea*, *Carex arcta*, *Carex cephaloidea*, *Carex vulpinoidea* and *Carex gravida* furnish much of the grass-like vegetation of the sloughs in June. In the shallow water of creeks a true grass, *Alopecurus geniculatus*, may be found showing its timothy-like heads. In deeper water the common cat-tail, *Typha latifolia*, may be seen, The tuffted loose strife, *Lysimachia thyrsiflora*, may be found nestling among the reeds and grasses, and in deep open water, that reptile-like appearing plant, *Hippuris vulgaris*, may frequently be found. Another plant found in the sloughs in June, is *Steironema lanceolatum*. It is toward the close of June, too, that the only shrub common to the sloughs, *Spiraea salicifolia*, is in bloom.

With the beginning of July another loose strife, *Steironema ciliatum*, is in bloom. It was on July 12th, 1888, that the writer collected *Bacopa rotundifolia* in a prairie slough in Lac qui Parle county, perhaps the only Minnesota collection ever made of this plant. Another slough plant to be looked for in July is *Lycopus americanus*. The arrow heads, *Sagittaria latifolia* and *Sagittaria cuneata* are now in bloom and *Scirpus lacustris* and *Scirpus americana* are fruiting in rather deep sloughs, along with *Sparganium eurycarpum*.

With the beginning of August the swamp milkweed, *Asclepias incarnata*, begins to bloom in grassy sloughs. *Berula erecta* is found in slow streams while *Cicuta maculata* and *Sium cicutaefolium* are found in deeper water. With the drying up of the sloughs in August several species of *Potentilla* become noticeable. Some of these are clearly *Potentilla monspeliensis*, others appear to be *Potentilla pentandra*, while still others may be Rydberg's *Potentilla leucocarpa*. It is in August too, that *Pedicularis lanceolata* is in bloom, while *Radicula hispida* and *Radicula palustris* are common in muddy places. This plant has been called *Nasturtium* and *Roripa*. *Phragmites communis* is now waving its shining purple panicles in the deeper sloughs, and in springy and boggy places the great water dock, *Rumex brit-*

tanica, is conspicuous. *Polygonom lapanthifolium* is common on moist grounds, while *Polygonum emersum* shows its dense rose-colored spikes in the deeper sloughs. This last mentioned plant when touched by the autumnal frosts gives forth a spicy fragrance never to be forgotten by one who has once inhaled it. *Beckmannia crucaeformis* is blooming in muddy places, or more generally growing out of the water. *Ranunculus macounii* may now by looked for on moist ground.

Early in September *Helenium autumnale* and *Solidago graminifolia* open their yellow heads on ground that has been wet all summer. The mininutive *Eleocharis acicularis* is growing in muddy places covering the ground like a carpet. *Ambrosia psilostachya* is now found in moist places. *Boltonia asteroides* is in bloom on all wet grounds, and its white star-like flowers do much to make the low lands look as white as the upland prairie where *Aster multiflorus* is in bloom. *Aster paniculatus* is found in the same low sloughs. The later autumnal flowers of low ground are *Bidens frondosa*, *Bidens leavis* and *Artemisia biennis*, and soon frost puts an end to the whole prodigal show.

3. The Prairie Meadow Flora.

The earliest of prairie grasses, *Hierochloe odorata*, has already been referred to. This grass matures so early as not to be an important constituent of the prairie meadows. *Poavcompressa* has been occasionally found, but is by no means common. A tall *Poa* collected at Clara City was identified at *Poa pseudopratensis* by Prof. Scribner. *Poa pratensis* is not often found in a natural meadow, but it is crowding out the native grasses by road sides and in pastures. *Panicum scribnerianum* is quite common in prairie meadows early in June; but it ripens early and does not contribute much to the hay crop. *Agrostis alba*, seemingly native, is quite common, but much more common is *Poa triflora*, a grass that forms a large part of the hay of prairie farmers. Among the weeds in the native meadows, must be classed *Hordeum jubatum*, a grass that seems to be more than maintaining itself. It furnishes good pasture early in the season, but its rough barley-like awns are very injurious to stock and often cause great damage to the hay crop. Among the coarser grasses of the prairie meadow is *Spartina cynosuroides*, growing to the height of from three to five feet. *Echinochloa crus-galli* is found blooming in August in the wetter parts of the prairie meadows. In many meadows the bulb-producing wild onion, *Allium canadense*, is common.

4. The Alkali Flat Flora.

On some western Minnesota prairies the soil is strongly impregnated with alkaline salts, especially where the surface is so level that the drainage is poor. In such places it would seem that "lye" from the ashes left from frequent burning of the prairies has accumulated until few plants can survive the trying conditions. On these flat prairies *Astragalus hypoglottis*, looking strangely like red clover, is frequently found. This is a circumpolar plant, and extends in similar locations across the steppes of Siberia. It is occasionally found in valley lands. Another plant of these locations is the common lousewort, *Pedicularis canadensis*. One might conclude from the notation of its range given by Britton and by Macmillan, that it is to be found only in wood-lands; but in western Minnesota, it is never found in such locations. The small white lady slipper, *Cypripedium candidum*, once common on these flat prairies, seems to have wholly disappeared. Another plant of early June quite indicative of alkaline conditions is *Zygadenus chloranthus*, with its long racemes of greenish flowers. Here too, several *Senecios* are to be found, probably *Senecio balsamitae* and *Senicio plattensis*. The long stemmed hawksbeard, *Crepis runcinata*, is to be looked for where alkali is unusually abundant. It seems to be a xerophytic plant with a large thickened root from which the long stems shoot up early in June. Britton's manual gives the habitat of *Zizia cordata* as "in woods"; the "Metaspermae of the Minnesota Valley" says that it grows in thickets and on gravelly banks in the southeastern part of the valley, but it is common in western Minnesota on flat alkaline prairies or around the borders of prairie meadows. It never grows in woods or thickets in this part of the state. The characteristic dock around the margins of saline springs is *Rumex persicarioides*. The red goosefoot, *Chenopodium rubrum*, common in the sea coast marshes, appears again in wet places in the alkaline prairies of western Minnesota. *Ranumculus septentrionalis* is common in valleys and on the borders of alkali spots; but the characteristic crowfoot of these locations is *Rannunculus cymbalaria*. Both of these plants are largely progagated by stolons; but the *Cymbalaria* is one of the finest examples of this mode of propagation. *Stachys palustris* is common in abandoned fields where the soil is too wet and alkaline for cultivation. It is quite variable and most of the leaves seem to be petioled. Perhaps it should be regarded as a distinct variety. In some of its forms it is very similar to *Stachys teucrifolia* Rydberg. The wild mint found here has generally been referred to *Mentha canadensis*, but this species has been reduced to a variety of *Mentha arvensis* in the seventh edition of Gray's Manual. *Lithrum alatum* is especially abundant on the flat sandy prairies of Swift county. A *Pycnanthemum* is also found—probably *P. virginianum*. It is well to remember in passing that in the region under consideration there is very little land so impregnated with alkaline salts as not to be covered with prairie grasses. There are mainly such species as are found in prairie meadows, dwarfed somewhat by the inhospitable soil.

5. *The Valley Flora.*

It has been said that the prairie flora is deficient in species but rich in individual plants. One who has journeyed for any great length of time on the open prairie becomes weary of the endless repetition of individuals, and comes out with a sense of relief upon a broad river valley such as that of the Minnesota. He will not find the grasses greatly different from those of the prairie meadow, unless it be those of bluff sides, and these will be spoken of further on.

On rich dry river bottoms one will find *Elymus virginicus L* in place of *E. canadensis L.* On low grounds he will find *Panicum capillare* and *Echinochloa crus-galli;* on river banks *Eragrostis hypnoides*, dwarf and creeping, and possibly in the slow river itself the stately and beautiful *Zizania palustris*. On low valley lands the grass flora differs but little from that of the prairie sloughs. Here we find as the prevailing grass *Sparatina michauxiana Hitch*, and here it reaches its best development. On higher lying bench lands is found *Andropogon furcatus*, associated, if the soil is pretty dry, with *Andropogon scoparius*. In early spring *Hierochloe odorata* is very noticable, and on lower ground later in the season *Panicum capillare* is common. Several species of *Cyperus* are found on river banks, and among them *C. erythrorhizos* and *C. strigosus*. The pasque flower is common on bench lands, and on lower levels in early May *Anemone caroliniana*, the most beautiful of spring flowers, opens its pale blue and white petals. The wild strawberry is now in bloom and appears to be *Fragaria virginiana illinoiensis*. The violet of our river bottoms has been thought to be *Viola pratinicola* Greene; but it needs more study. Some of our plants appear to be *Viola cucullata* Ait, or *Viola papilonacea* Pursh. *Viola palmata* has been collected here but is very rare. *Caltha palustris* is a common spring flower here, occurring in wet meadows. *Sisymbrium incisum* Engl. or *Sophia incisa* Green is common on bench lands. The variety *hartwigianum*, or *Sophia hartwigiana* Greene, has been collected at Big Stone lake. *Capsella Bursa-pastoris* is an introduced weed, while *Ellisia Nyotelca* is a very common native, and sometimes becomes a troublesome weed in grain fields and gardens. *Corydalis aurea* is plentiful near rocky ledges, blooming in the latter part of May.

Among the valley flowers of early June are several *Senecios*. *Senecio palustris* is found on the shores of lakes, as well as in the valleys. *Senecio integerrimus* Nutt and *Senecio atriapiculatus* Rydb, are both referred by Dr. Greenman in his revision of Senecio in the seventh edition of Gray's manual to *Senecio integerrimus*, but the Montevideo specimens seem to be quite distinct. Perhaps a further study of a larger number of specimens would show that the two species run into each other. The wind flowers make a brave show in early June. The most common of these, *Anemone canadense* L. *Anemone virbineana* L., is quite rare here, but *Anemone cylindrica* is quite common. Its fruiting heads continue to elongate after the flowers are gone and become quite conspicuous. The spiderworts are now in bloom. Our plant appears to be *Tradescantia bracteata* Small. The typical milkweed of the river bottoms is *Asclepias syriaca* L, although *Asclepias ovalifolia* is occasionally found. *Asclepias speciosa* is confined to wet places on the high prairie. *Erysinum chiranthoides* is common along the borders of timber on dry soil. *Erysinum styrticolum* Sheldon has been collected at Ortonville, but in the opinion of Dr. Robinson it should be united with the rather more common *Erysimum inconspicum* MacM., and both plants referred to *Erysimum parviflorum* Nutt. *Silene antirrhina* L. is more or less common, and *Silene noctiflora* L, has been collected on the railroad track at Montevideo. *Euphorbia dictyosperma* Fisch & Mey has been collected in the valley both at Montevideo and Granite Falls. The Montevideo Station is the only one referred to in the "Metaspermae of the Minnesota Valley." The new edition of Gray's manual omits Minnesota from its range. This is doubtless due to the reduction of *E. arkansana* and *E. missouriensis* to the above named species. *Potentilla anserina* is common in wet meadows, and *Potentilla paradoxa* has been collected at Big Stone lake. *Galium boreale* is a very common valley plant in the latter part of June. When in full bloom it frequently whitens acres of land at a time. Thot cosmopolite, *Achillea millefolium*, is also found. *Scrophularia leporella* Bicknell is frequently found on the edges of valleys. *Myosurus minimus* is a very rare plant in this region, but it has been collected at Ortonville and Montevideo. *Camelina sativa* has been collected on the railroad right of way at Montevideo. *Prunus pumila* has been collected at the foot of Big Stone lake, and on the Leaf hills in Otter Tail county. Perhaps the shrub found at the latter location is *Prunus cuneata Raf.* The common cornel found in the valleys here seems to be *Cornus stolonifera* Michx. The fact that it is not stoloniferous has led Dr. Rydberg to propose for it the varietal name of *interior*. *Cardamine bulbosa* is frequently found in spring brooks.

The July flora is not so conspicuous. The two sweet clovers, *Melilotus officinalis* and *Melilotus alba*, both introduced plants, are blooming on waste grounds. In similar locations *Lappula virginiana* a distinguished looking plant when young, is producing its inconspicuous flowers or ripening its prickly-barbed fruit, a sad disappointment to one who has watched its growth. *Euphorbia marginata* Pursh is not common in this region, but is found on the southwesterly edge of our area growing in alluvial soil. *Lobelia spicata hirtella* is common in valley meadows. *Teucrium occidentale* Gray, or its variety *boreale* (Bicknell) Fernald, is found at the foot of bluffs where the soil is rich. *Apocynum androsemifolium* is now blooming in open places, and *Apocynum cannabinum* in its variety *hypericifolium* is found along the edges of timber land. *Echinocystis lobata* is twining its graceful stems over shrubs and fences, opening its long racemes of pale flowers in profusion. *Utricularia vulgaris* in its variety *americana* is thrusting up its yellow flowers in marshy ponds; *Erigeron philadeplhicus* is blooming in moist places, while the small flowered *Erigeron ramosus* is blooming on dry bench lands. Other Compositae are now beginning to bloom, *Sylphium perfoliatum* in rich alluvial soil, *Veronia fasciculata* in low grounds, and *Eupatorium purpurem* in still moister places.

August shows many more blooming plants. Perhaps the rarest of these is *Cassia Chamaecrista* found on the river banks at Granite Falls. *Scutellaria lateriflora* is blooming in wet places, while *Ranunculus pennsylvenica* is ripening its fruit in similar locations. At the foot of bluffs are found *Verbena hastata*, *Verbena stricta*, *Verbena urticaefolia* and at Big Stone lake *Verbena bracteosa*. The pink umbels of *Allium stellatum* are now seen on rocky banks everywhere. *Sisymbrium officinale* is ripening its seeds in waste places, while *Sisymbrium altissimum* is becoming a troublesome weed along railway tracks and in grain fields. *Plantago major* is exceedingly common and was doubtless a native here. *Cuscuta gronovii*, *Cuscuta glomerata* and perhaps *Cuscuta arvensis* are found on various plants, mostly *Compositae*. *Hieracium umbellatum* is quite a rare plant in this region, but has been collected at Big Stone lake. It is believed that *Artemisia graphalodes* has been collected in the valleys here, but as that species has been united with *Artemisia ludoviciana* it will have to be called by the latter name. *Dalea alopecuroides*, formerly *Paroseia Dalea*, is occasionally found on river bottoms here. *Polanisia trachysperma* T. & G, seems to have been collected in the river valley at Montevideo, although that location is somewhat outside of its range. *Polanisia graveolens Raf.* is a very common plant on lake shores. *Acorus Calamus* has been collected at Carlton lake, Montevideo, but is very rare in this part of the state. *Strophostyles pauciflora* (Benth) Wats., a rare leguminous plant here, is found at Big Stone lake. The typical river valley thistle is *Cirsium altissimun*, sometimes growing to the height of seven or eight feet. In the Minnesota river near Biw Stone lake there has been collected *Mryiophyllum spica tum* and *M. verticillatum* and they are doubtless common in suitable locations throughout this part of the state. The common blazing-stars of the river valleys are *Liatris scariosa* and *L. pycnostachya*, the former growing on higher and dryer ground. The river valley sunflower is *Helianthus grosse-serratus* Willd., while the broad-leaved species found near the edges of the timber is *Helianthus tuberosus*.

In late summer *Lobelia syphilitica* is common in wet meadows. The *Lactucas* are represented by *L. canadensis*, *L. hirsuta*, *L. ludoviciana*, and *L. pulchella*, the latter being quite common. *L. scariola integrata* is too common in gardens. *Thlaspi arvense* is spreading rapidly along railway embankments and promises to become a troublesome weed. What seems to be *Spiranthes gracilis* is frequently found in wet meadows. *Grindelia squarrosa* is found at Montevideo near the railroad track, and along the State line south of Gary.

Among the fall asters of the river valleys may be mentioned, *Aster salicifolius* and *Aster latcriflorus* growing on low ground. *Aster laevis* is found on higher ground along the edges of timber, while *Aster novae-angliae*, the most beautiful of asters, is found along spring brooks. *Boltonias* are common in wet places and contribute much to the beauty of the autumnal landscape.

6. *The Bluff Flora.*

It is along the bluffs of the river valleys that there is found the greatest number of plants having a western range. The grass flora resembles that of the upland prairie, including *Andropogon scoparius*, *Bouteloua curtipendula*, *Bouteloua oligostachya*, *Agropyron smithii*, *Agropyron tenerum*, *Stipa spartea*, *Sporobolus heterolepsis* and *Calamovilfa longifolia*.

Among the early spring flowers may be noted *Agoseris cuspidata* with flowers much like a dandelion. This genus has been called *Troximon* and *Nothocalais*. One of the showiest bluff flowers is *Pentstemon grandiflorus*, but it is rather rare in this region. *Pentstemon gracilis* has been collected at Ortonville, and *Penstemon albidus* is plentiful at Montevideo. Two other common bluff flowers are: *Lithospermum angustifolium* and *L. canescens*. *Geum triflorum* with its purple calyx and long plumose styles is a very showy object in May and early June. Another May flower on prairie knolls is *Allium reticulatum*. It is quite dwarf and has white flowers. *Astragalus adsurgens* forms dense caespitose masses on prairie knolls, its dense spikes and purplish flowers making it look something like red clover. *Astragalus lotiflorus*, Hook, is found on dry banks, or near the tops of bluffs where the ground is very dry and hard. In suitable locations it is quite plentiful. The flowers are inconspicuous. *Astragalus missouriensis* Nutt., while not admitted into the new edition of Gray has been collected at Ortonville. The "Illustrated Flora" gives its range as from Nebraska to the Northwest Territory and south to New Mexico. It seems to be native at Ortonville, and not an introduced plant. *Astragalus flexuosus* Doug. has been collected at Montevideo and is very plentiful near the railway station at Ortonville. *Oxytropis lamberti*, Pursh. is a very showy plant on bluffs throughout the upper Minnesota valley. It has been called a loco weed, but I have never heard of stock being poisoned by it. *Onosmodium hispidissimum*, Mackenzie, is very common throughout this district. It was impossible to make our plant agree with any of the descriptions in the old manuals and it is some satisfaction to know that there is a new species for it. *Gaura coccinea* is not an uncommon plant here. Its rose or scarlet flowers make it very beautiful. *Oenothera serrulata* is another June plant very common along bluffs. Its yellow flowers remain open all day. Our larkspur seems to be *Delphinium azureum*, and it too, is quite conspicuous along the bluffs in June.

Two yellow flaxes are very noticeable along the bluffs during July —*Linum rigidum* and *Linum sulcatum*. *Ascelepias verticillata* is often found on bluffs and may be counted a bluff plant, although it is found on level prairies as well. Another mid-summer plant found on bluffs and high rolling prairies is *Brauneria angustifolia*, noticeable for its large heads and long purplish rays. This plant was known to old frontiersmen as thirst weed. Its gray-colored thickened roots were used by early travelers as an antidote for thirst. Taken into the mouth it has a salty, peppery taste, increasing the flow of saliva so that the weary treveler forgets that there is no good drinking water to be had. *Coreopsis palmata* is another July Composite, quite showy and beautiful. In dry sandy places one is quite sure to find the golden aster, *Chrysopsis villosa*, with its rough gray leaves and branches and yellow flowers. Another July bluff plant is the green milk weed, *Acerates viridiflora lanceolata*. A typical xerophytic plant found on sandy bluffs is *Lygodesmia juncea*. It has scarcely any leaves and seems to delight in the dryest and most sterile soil. Quite a rare plant on dry sandy bluffs is *Oenothera pallida*, a white flowered evening primrose. It has shreddy white bark. Our horsemint appears to be *Monarda mollis* and is found on dry banks in early August. *Polygala verticillata*, with greenish flowers, is found on dry ground. It is not a conspicuous plant, and is one that is apt to be overlooked. *Artemisia frigida* is found on the dryest bluffs, sometimes whitening the whole bluff side, as seen from a distance. *Artemisia longifolia* is quite common in similar locations. A not uncommon aster on the bluff lands is *Aster oblongifolius*, with beautiful purple flowers. Another striking plant of the bluffs is *Aster sericius* with silvery silky leaves. *Kuhnias* are very common plants on the bluffs. Our plant seems to be *Kuhnia eupatoroides*. The attempt to separate this variable species into two or more species seems to have ended in failure. The blazing stars of the bluffs are *Liatris cylindricea* and *Liatris punctata*, the latter more common. *Liatris scariosa* is also frequently found on bluff lands, where *Lepachys columnaris* is also quite common. *Rudbeckia hirta* is not very common near the Minnesota river but is found on the Leaf hills. *Oxybaphus nyctagineus* and *Oxybaphus hirsutus* are both found on dry banks, the latter more common. Both open their flowers late in the afternoon. *Polygonum ramosissimum*, Michx, is the name now given to our tall dry-land knot-weed. Heretofore we have called our plants *Polygnomum camporum*—at least for the most part. *Artemisia dracunculoides*, Pursh is an early autumn plant on dry land. *Artemisia caudeta* is found on thinner soil, usually near rocks.

7. *The Rock Flora.*

The Minnesota valley, as we have remarked, is crossed in several places by ridges of archaic rocks. Near these rocks and in crevices in them, the conditions are even more xerophytic than on the bluffs. The grass flora of these rocky areas does not differ greatly from that of the bluffs. *Bouteloua oligostachya* here reaches a better development. Indeed this valuable grass seems to be more than maintaining itself, and is becoming an important constituent of dry pastures. *Sporobolus brevifolius* belongs in the same plant society as the *Bouteloua* and is usually found with it. *Festuca octoflora* is found on thinner soil and ripens its seed in early summer. *Agrostis hyemalis* is another rock grass, although of course it is found in many other places. Growing in shallow pools on the rocks is a dwarfed form of *Alopecurus geniculatus*, not more than two decimeters high. It seems to be a distinct variety. Growing among the grasses in these rock areas, *Juncus tenuis* is quite a common plant.

Selaginella rupestris is common on the rocks with many interesting mosses and lichens. The common fern found in the crevices of these rocks appears to be *Woodsia ilvensis*. The only other ferns that have been found here are *Cystopteris fragilis* and *Polypodium vulgare*, but both of these are quite rare.

The earliest spring flower in these areas is *Lomatium orientale* (Coulter & Rose). It blooms in April, sending up its umbel of white flowers from a thick fusiform root stock. Blooming at a time when the prairies are still gray with the last year's grasses, it is a difficult plant to find. Early in May *Androsace occidentalis* is a very common but rather inconspicuous flowers. Associated with this plant, but not so common is *Draba Caroliniana*, another very dwarf plant. Growing on the rocks, or where the soil is very thin *Draba nemorosa* is very common. It is very small in early spring when it commences to bloom, but the plant forks repeatedly and continues to bloom and fruit until it reaches a height of at least three decimeters. *Aquilegia canadensis* grows under the shadow of these rocks and is one of the most beautiful spring flowers. *Arenaria lateriflora* has been found in similar locations. *Myosotis virginica* is a rather common plant growing in the crevices of the rocks. *Gillia linearis*, a western plant, is found on the rocks at Cedar lake near Montevideo, but is not very common. *Acerates lanuginosa* is another rare plant of these rocky ledges. Perhaps one of the smallest plants to be found among these rocks is

Centunculus minimus. Another diminutive rock plant is *Gratiola virginiana* growing in the shadow of rocks. *Plantago purshii* is very common on dry ground near these rocks. *Hedeoma hispida* is common too growing on rocks, while *Heuchera hispida* grows on dry soil near by. *Arabis hirsuta* as found on the rocks here is a plant of considerable size. *Isanthus brachitus* is a little plant blooming in the crevices of rocks in July. *Manillaria vivipara* is found on granite ledges near Ortonville. Its bright red flowers are very beautiful. *Opomeia fragilis* is common on the rocks in all parts of the upper Minnesota valley. *Hosackia americana* (lotus) is quite plentiful around Big Stone lake and has been collected as far east as Montevideo. Other plants of a western range collected at Montevideo are:

Potentilla hippiana; Potentilla pennsylvanica strigosia Pursh.; *Potentilla pennsylvanica; Talinum parviflorum* Pursh.; *Houstonia longifolia*, common on the rocks; *Polygonum tenue*, also very common on gneiss rocks, fruiting in September. *Pernathes aspera* Michx, is frequent on rich bench lands near rocks. It is a stately looking plant with a southwestern range.

8. *The Bog Flora.*

There are few bogs in western Minnesota, consequently the list of bog plants is short. Among the plants found about springs and in wet places are: *Epilobium coloratum*, Muhl.; *Epilobium densum*, Raf.; *Epilobium adenocaulon*, *Mimulus glabratus Jamesii*, Gray, found in cold springs; *Callitriche heterophylla*, Pursh, collected in Spring creek, near Montevideo; *Gentiana procera*, Holm., found in marshy bogs near Glenwood.

Lobelia kalmii, L. found in spring bogs in Pope county, *Parnassia caroliniana* found in bogs around lake Minnewaska.

Some of the names used in this paper have an unfamiliar sound. This is due to the action of the Vienna Congress in restoring to use certain generic names that have not been used by American botanists for many years. For the sake of uniformity it is likely that their use will have to be acquiesced in.

THE PRAIRIE LEGUMES OF WESTERN MINNESOTA.

By Lycurgus R. Moyer, Montevideo, Minn.

It may seem presumptuous in one whose knowledge of field botany is only that of an amateur to come before this Academy with a paper on so threadbare a topic. The general subject of the Minnesota flora has already been ably discussed by Dr. Upham in his "Catalogue of the Flora of Minnesota," published as Part VI. of the annual report of progress of the Geological and Natural History Survey of Minnesota, for the year 1883. This scholarly work, while admittedly incomplete, was contributed to by botanists from all parts of the state. and represented at the same time the field observations of Dr. Upham himself while engaged in the actual field work of the geological survey. Eight years later, in 1892, there appeared the much more elaborate and pretentious work of Prof. Conway MacMillan, entitled "The Metaspermae of the Minnesota Valley." Of this work it may be said that it was based on insufficient field work, and so abounds in conclusions not warranted by the facts. Valuable papers on the Flora of Minnesota appeared from time to time in the "Minnesota Botanical Studies," particularly the papers by Sheldon, Heller and Wheeler. The only special report on the flora of western Minnesota, is a paper by William A. Wheeler, entitled "A Contribution to the Knowledge of the Flora of the Red River Valley in Minnesota," (Vol. 2 Minn Bot. Studies 569), in which there are enumerated twelve prairie plants and shrubs belonging to the Leguminosae. The second volume of Britton & Brown's "Illustrated Flora of the Northern United States and Canada" appeared in 1897, and covered western Minnesota in a more satisfactory way than any other publication. It seems likely, in view of the Vienna agreement, that its system of nomenclature will soon seem antiquated. Robinson & Fernald's "Gray's New Manual of Botany" is a very helpful book, but its plant descriptions are too brief to be entirely satisfactory, and it already appears that it omits some Minnesota plants. Coulter & Nelson's "New Manual of Rocky Mountain Botany" is a disappointment in that it is quite locally confined to a small part of the Rocky Mountain region with Wyoming as a center, and does not purport to cover the plains and prairies at all. It has been the hope of western botanists when they found that the "New Gray's Manual" was limited to the regions east of the western boundary of Minnesota, that the New Rocky Mountain Botany would cover the adjacent regions to the west. The book was therefore a disappointment, but it leaves the field open for some enthusiastic young man to write a plains flora, or perhaps a Flora of the Mississippi Valley. It may be said that the plains flowers are not very attractive, but it will be found that they are well adapted to their environment, and therefore worthy of careful study.

It is perhaps generally known that western Minnesota is for the most part a high rolling prairie, from 1,000 to 1,800 feet above the level of the sea. The largest area of level land in this region is the

Red River valley, the ancient bed of the glacial Lake Agassiz. The observations noted in this paper are more pertinent to the high rolling prairie regions lying south of the Red River valley proper. These prairies are practically all of a drift formation. The regions to the north of them, or perhaps western Minnesota itself, seems at one time to have been underlain by extensive formations of limestone which became food for the glacier, and was ground up and incorporated with the other materials in such a way as to produce a soil of surpassing fertility. In respect to the amount of decomposing limestone found in the soil, western Minnesota differs markedly from eastern Minnesota, or from Wisconsin, and the difference is all in its favor. An outcrop of granitic rocks crosses the state from its northeast corner to its southwest corner, but the material from which the extraordinarily fertile soil of western Minnesota was formed was very largely sedimentary rocks abounding in carbonate of lime. Very few exposures of this rock are now to be found remaining in place. There is found on the northeasterly side of Big Stone lake about half a mile from its head an outcrop of shale bearing many concretions, apparently gypsum crystals, but the exact nature of these so far as the writer knows has not been determined. Prof. Todd of the United States Geological Survey is of the opinion that this outcrop is Carlisle shale of the Benton group. Should this opinion prove to be correct one might hazard a guess that the immense number of large and powerful springs found along the southwesterly side of Big Stone lake are due to the running out in this locality of the water bearing Dakota sandstone.

Rich as this soil is minerally, it is probable that part of its fertility is due to the action of nitrifying bacteria which found congenial hosts on the roots of leguminous plants formerly so abundant on the prairie. This is merely suggested without any purpose of going into the extensive literature of this branch of the subject. Certain it is that those parts of the prairies lying highest and driest and apparently possessing the least fertile soil have produced the best crops for many years, some having stood continuous wheat cropping for forty years. Lands lying on a somewhat lower level and apparently possessing much more soil humus, have not been nearly so productive; and it is a fact that the original prairie sod in such locations did not contain nearly so many leguminous plants. It has been noticed, too, that those portions of the original prairie that have been fenced and long pastured and afterwards broken up and planted to ordinary farm crops have not been nearly so productive as the prairies that were broken without being pastured. It is reasonable to believe that there must be some connection between this lack of fertility and the fact that the leguminous plants were so quickly destroyed by cattle.

Like the buffalo the leguminous flora of western Minnesota has now practically passed away, and the traveler on the prairies sees only farm crops, or waste pieces of land bearing weeds of various kinds, many of them bing immigrants from Europe. It seems proper to put on record some account of these plants before the memory of them entirely dies out. They practically exist now only in herbaria, or as isolated individuals in waste places or along railway rights of way; and even in such places they are being rapidly driven out by more persistent vegetation. Kentucky blue grass is driving out the original prairie grasses as well as the leguminous plants.

As nearly as the writer can remember the most common of the prairie legumes was *Psoralea argophylla* Pursh, and it was the silvery silky-white pubescence of this plant that contributed so much toward giving the prairies their prevailing gray tint. It is a plant of wide distribution all over the northwestern plains.

On high rolling prairies, and on bluffs and ridges, one was sure to find *Psoralea esculenta* Pursh, a hairy grayish looking plant with the aspect of a lupine. Deep in the tough prairie sod was buried its oval or oblong farinaceous root. Encased in its tough leathery exterior these roots supplied a white starchy and mealy interior of agreeable flavor. This plant, the tipsini or teep-se-nee of the Indians, the Pomme de Terre of the French voyageur, was the source of a large part of the food supply of the natives. It is said the Indians dried it and made it into flour which was used for thickening soups and for other purposes. The young men who followed the early breaking plows on the western Minnesota prairies can testify that the roots were very good eaten raw. The Pomme de Terre river received its name from the abundance of this plant on the sandy prairies along its banks near where it was crossed by the old Joe Brown trail.

When Prof. Holzinger was a home missionary in Cottonwood county he collected *Psoralea tenuiflora* Pursh, in that county, but it was a rare plant. It was afterward collected between Morton and Granite Falls by Prof. MacMillan.

The common ground-plum of the Minnesota prairies was known as *Astragalus caryocarpus* Ker. in the old manuals, and bears the same name in Robinson & Fernald's New Manual. Dr. Rydberg separated it from Astragalus and proposed it the new genus Geoprumnon. Prof. Nelson in the New Manual of Rocky Mountain Botany leaves the plant in Astragalus as did Dr. Britton, but favors the division of the old species so that our plant becomes *Astragalus crassicarpus* Nutt. It was very common in the early days, and tradition tells us that its fleshy pods were frequently cooked by travelers as a substitute for green peas. One writer has testified that its flavor is midway betweeen that of green peas and asparagus. For many years back the plant has been so infested with "pea bugs" that no one would care to eat the dish.

The widely distributed *Astragalus Carolinianus* L, or *A. Canadensis* L. extends throughout western Minnesota but it was nowhere very common. It was found on prairies, in valleys and along river banks. The specific name "canadensis" is used in the new Gray's Manual and by Dr. Rydberg in his Flora of Colorado, while the New Manual of Rocky Mountain Botany follows Dr. Britton and Dr. Small in preferring the name "carolinianus." It seems that both names appear in Linnaeus' "Species Plantatrum," "carolinianus" being No. 9 and the other No. 10.

At widely separated intervals over the prairies of the western part of the state there are found knolls often of considerable height formed of drift materials, which may be considered as either remnants of moraines or water formed kames. It is an interesting fact of plant distribution that it was on the tops of these kames, and nowhere else on the prairies, that were to be found in the early days fine specimens of *Astragalus nitidus* Doug., usually called *Astragalus adsurgens* Pall. in the early reports. This plant grew from a deep tap-root, and its exceedingly numerous stems, branching only at the base, formed a dense matted clump. Its compact spikes of purplish flowers have something of the aspect of heads of the common red clover. The New Gray's Manual regards the plant as identical with *Astragalus adsurgens* Pall, but that species is regarded as growing only in Asia by Dr. Rydberg, and by the New Manual of Rocky Mountain Botany.

On flat alkaline prairies and sometimes in river valleys *Astragalus hypoglottis* L. was very common in the early days. It is a slender little plant and does not form dense clumps as do many other of the Astragali. The New Rocky Mountain Botany regards it as identical with *Astragalus goniatus* Nutt., but Dr. Rydberg is of a different opinion and regards the Siberian plant as distinct from the American.

On the slope of a railway cut at Ortonville there were collected in 1898 a few specimens of *Astragalus missouriensis* Nutt. This plant is new to the flora of the state, and the writer was at first inclined to think that it had been introduced by the railway; but a visit to the same locality a few years later led to finding many specimens in the vicinity growing in the original prairie sod, so that it may be regarded as truly indigenous. The plant is not mentioned in the New Gray's Manual so that it is an addition to the "Manual region" as well as to the flora of the state. This plant has been separated from Astragalus by Dr. Rydberg, and is placed by him in his new genus Xylophacos.

Growing toward the summits of rather steep banks and bluffs where the sod is somewhat broken up by the washing of rains one is apt to find *Astragalus lotiflorus* Nutt. This plant is placed by Dr. Rydberg in the old genus Phaca. But if one will compare a well developed fruiting specimen of *Astragalus lotiflorus* with a similar specimen of *Astragalus missouriensis* it will be very hard to believe that the two plants belong to two distinct genera. It seems best to leave them both in Astragalus. Perhaps some of our western Minnesota plants belong to Sheldon's *Astragalus eliocarpus* but a comparison of the plants with specimens from Colorado leave the matter in great doubt.

Astragalus flexuosus Doug. was collected at Montevideo in 1885 but the station soon became obliterated. It is quite common near the railway yards at Ortonville. Dr. Rydberg would place this plant in Nuttal's old genus Homalobus.

Sheldon reports the collection of *Astragalus tenellus* Pursh in Otter Tail county, and it seems likely that one of the writer's collections at Ortonville was this species. Dr. Britton places this species in Homalobus, as does Dr. Rydberg in his Flora of Colorado.

Along the summits of bluffs and on prairie knolls *Aragallus Lambertii* (Pursh) Greene is a fairly common plant, and always an object of interest. It is one of the Loco weeds and is common in bluffy pastures, but no instance of cattle poisoning from eating it has come to the writer's knowledge. The New Gray's Manual uses the name Oxytropis for the genus, while Dr. Britton used the name Spiesia in the Illustrated Flora and the name Aragallus in the Manual.

Wild Licorice, *Glycyrrhiza lepidota* Pursh, was fairly common on rich moist prairies, growing sometimes where the soil was partly alkaline. The root of the wild species seems not to be so sweet as the licorice of commerce.

The boys who broke the prairies of western Minnesota forty years ago have vivid recollections of the Devil's Shoe Strings, the plant with so tough a root that it would double around the sharpest plowshare and clog the breaking plow. This plant is *Amorpha canescens* Pursh, and it was very common. Its whitened foliage did much to give the prairies their characteristic gray tint. *Amorpha nana* Nutt., called *Amorpha microphilla* Pursh in the New Gray's Manual, was less common. Its foliage was green and glabrous and its spikes of bright purple flowers were very showy. *Amorpha fruticosa* L. was common on the banks of streams, but it could hardly be called a prairie plant.

Parosela dalea (L) Brit. or *Dalea alopecuroides* Willd. as it is called in the New Gray, was found occasionally, but it was a rare plant.

Among the prairie clovers *Petalostemon candidus* Michx was common, and it is probable that *Petalostemon oligophyllus* (Torr.) Rydb. was common too, but the two species have so much in common as to be difficult to distinguish. *Petalostemon purpureus* (Vent.) Rydb, was common, too, while *Petalostemon villosus Nutt.*, so common in the eastern part of the state, was either absent or very rare.

The Perennial Pea, *Lathyrus venosus* Muhl., was quite common in especially rich ground, near gopher mounds. *Lathyrus palustris* L. was common, too, especially in its variety, *Lathyrus palustris linearifolius* Ser.

One Lespideza, *L. capitata* Michx., may be recorded as a prairie plant, but it was nowhere very common. It was usually found on dry banks and bluffs.

Lotus americanus (Nutt.) Bisch., or as it is called in the New Gray's Manual *Hosackia americana* (Nutt.) Piper, appears never to have been very common in this region but has been collected by the writer at Big Stone lake and Montevideo, and by Sheldon at Lake Hendricks.

These western prairies can scarcely claim more than one Desmodium, *D. canadensis* (L) DC., and this was nowhere very common, and did not grow far from bluffs and river valleys.

Strophostyles pauciflora (Benth.) Hook. has been collected by the writer as far west as Big Stone lake, but it can hardly be called a prairie species.

Vicia americana Muhl. was common throughout the prairie region, in rich moist places, and *Vicia linearis* (Nutt.) Greene, a western species, has been collected as far east as Ortonville.

In conclusion it may be said that the prairie Legumes while belonging to but few species were rich in individuals, and probably contributed much to the fertility of the prairies.

PREHISTORIC ABORIGINES OF MINNESOTA AND THEIR MIGRATIONS.

N. H. Winchell.

[Paper written for the Minnesota Historical Society, and read Feb. 9, 1907.]

(ABSTRACT.)

Prof. Winchell based his dscussion on the latest results of the study of the Glacial period, and the conclusions of the Bureau of American Ethnology. He said that by the former the farthest back that we hope to trace the human occupancy of Minnesota is not more than five or six thousand years, that being the approximate date at which the state became habitable after the retirement of the ice of the last Glacial epoch.

He called attention to the map of late major Powell showing the distribution of the original linguistic stocks of the American aborigines, which number between fifty and sixty; and to some of the remarkable features of that distribution. He showed that after the Glacial period the tribes resident along the Pacific and the Atlantic coasts, and on the gulf coast began a slow migration into the country that had before been uninhabitable lying toward the north. The vanguard of the tribes moving from the southwest was held by the Athapascan and the Algonquian, and from the southeast by the Iroquois and the Sioux. Remnants of these tribes still reside in their pristine seats, and their dialects, which have been carefully studied, are found to be more archaic than the body of the same now known further north, showing that these remnants were the parents of the more northern dialects.

The valley of the Ohio and much of the adjacent country were occupied by the migrating Sioux and they became the celebrated mound builders of the region. The Algonquian, moving from the southwest, took possession of the timbered region of the northwest, extending to Hudson's bay, the whole of Minnesota probably being occupied by them. This constituted the first great migratory movement.

Then began a great war—the result of which was the disruption and expulsion of the Ohio mound builders. This is confirmed by traditions, and by some sub-historic facts. The Algonquians of the northwest moved southeastwardly and crossed the Mississippi in a hostile incursion near the southern boundary of Minnesota, and finally drove the mound builders who have now been learned to have been the Cherokees and some cognate subtribes, out of Illinois and Ohio and into Virginia and North Carolina, where they were met by De Soto and where they were still building mounds.

Many of them escaped down the Ohio valley, and at its mouth they divided, a part of them returning again to Minnesota and to Iowa, and there establishing, or renewing, the dynasty of the mound builder, this later phase being distinctively called the Minnesota dynasty. It is this migration that brought the present Sioux into the northwest, an event which is believed to have been not more than 500 years ago.

After this the Ojibwa (Algonquian) stock made another successful raid on the Dakota tribes, and gradually pushed them again further south, and recaptured the northern half of the state of Minnesota. This last movement is verified by some historic facts, and by abundant tradition. It was during this war that the whites appeared on the scene. The conclusion of the paper summarized the human migratons that have passed over Minnesota as follows:

1. Algonquian occupancy from the southwest. (During this epoch the Ohio mound builders flourished.)

2. General hostile movement against the mound builders by the Algonquian (Kilistino?) tribes from the northwest, resulting in the destruction of the Ohio dynasty.

3. Fugitive mound builders return up the Mississippi river and possess the country under the second, or Minnesota, dynasty, occupying the southern part of the state, say 500 years ago.

4. The Sioux again driven away, at least from the northern part of the state, by the Algonquian stock, 150 years ago.

5. Aryan civilization.

HENNEPIN AT THE FALLS OF ST. ANTHONY.

N. H. Winchell, Minneapolis.

[Read June 2, 1908.]

In order to appreciate the personal circumstances which characterized the historic scene of Hennepin's discovery of the falls of St. Anthony, it will be necessary to recall briefly the events that led up to the discovery.

It will be remembered that he was a Franciscan priest, somewhat of an adventurer, who had formerly been a soldier, and who had volunteered to accompany La Salle on his perilous exploration of the Mississippi river. With two traveling companions he had been dispatched by La Salle in the spring of 1680 from his fort on the Illinois river, to ascend the Mississippi and inaugurate friendly relations with the Indian tribes and incidentally to begin a trade in beaver skins, for which latter purpose he was furnished with a supply of goods and trinkets such as are desired by the natives. At the same time, geographical knowledge of the unknown regions which would serve to extend the domains of the king of France, and the conversion and baptism of the savages, which would extend the influence of the Roman Catholic church, were subsidiary objects which were to be always borne in mind.

This party was surprised and captured, and robbed, by a roving party of Sioux Indians at some point not far above the mouth of the Wisconsin river. They were conducted, as captives, across the country from some point near Dayton's bluff, in St. Paul, to Mille Lacs in Mille Lacs county, the source of the Rum river. During this arduous trip the Indians quarreled amongst themselves as to the division of the spoils which they had won, and which they laboriously carried along with them. Hennepin became sick and exhausted, but was treated by the Indians, on their arrival at the end of their journey, with a hot steam bath, for which they specially constructed a suitable hut, and after which repeated three times a week, he regained his health and his usual strength.

Hennepin remained several months amongst the Sioux at Mille Lacs, where according to his account of his captivity, he was held as a captive and as a slave. It will be well to enumerate some of the deprivations which he suffered:

(a) His canoe had been broken to pieces when they left the Mississippi at St. Paul.

(b) His goods had been pillaged and divided amongst three of the Sioux bands.

(c) He was adopted by Aquipaguetin as his son, and was consigned to the care of his wives, with instructions to regard him as one of their children, as a substitute for one that had been killed by the Miami.

(e) His sacred articles were taken away from him, and in order to perform baptism on a dying child he wrested a half of a linen altar cloth from the hands of an Indian who had stolen it from him, and put it on the body of the baptised child.

(f) His chasuble had been desecrated by the son of Aquipaguetin, who had used it to wrap up some of the bones of his deceased relatives, and swinging the bundle over his shoulders had paraded through the village. It had then been presented to some of their allies, situated about 500 leagues to the west.

(g) Hennepin was required to serve as barber for the heads of Indian children, and as surgeon for bleeding persons afflicted with asthma, and he also administered a never-failing drug (orvietan) to others who were sick.

It appears therefore that his life with the Sioux at Mille Lacs was one of deprivation and of hunger; and when the Indians were preparing to take him on their annual buffalo hunt his fellow countrymen heaped upon him the crowning act of ingratitude and insult. The three Frenchmen were given a canoe for their joint use in descending the Mississippi; but Accault and Du Gay refused to give him passage in it, and paddled off without taking him, one of them shouting out to him that he had paddled the Franciscan far enough already. He was afterward taken in however by two Indans. It is evident that in this emergency Hennepin was reduced to the lowest pittance of earthly possessions. In this condition he was compassionately conveyed by the Indians as far as the mouth of Rum river where the whole party halted for some time for the purpose of replenishing their stock of canoes.

Events which took place here, united with what precedes, have an important bearing on the personal appearance of Hennepin at the falls of St. Anthony. At the Indian camp Hennepin remembered that La Salle had promised to send him additional supplies and messages from the Illinois, to meet him at the mouth of the Wisconsin river. This delay, at the place which is now known as Champlin, opposite the mouth of Rum river, was galling to him, and he solicited permission from the chief of the Sioux to descend in advance of meet these dispatches at the mouth of the Wisconsin. This was granted and Du Gay was also permitted to accompany him, Accault preferring to remain with the Indians. These two forlorn and adventurous Frenchmen set out in a small, leaking, birch canoe. They were given an earthen pot, and a gun and a knife. They had a single robe made of beaver skins which was to serve them together. They had no guide nor assistants. *This is the party that discovered the falls of St. Anthony.* It consisted of two, ragged and hungry Frenchmen hastening to an appointed place to get supplies and news from La Salle.

The particulars of this discovery are given briefly by Hennepin in the following words:

"This cataract is forty or fifty feet high, divided in the middle of its fall by a rocky island of pyramidal form. * * * As we were making the portage of our canoe at the falls of St. Anthony of Padua we perceived five or six of our Indians who had taken the start, one of whom had climbed an oak opposite the great fall, where he was weeping bitterly, with a well-dressed beaver-robe, whitened inside and trimmed with porcupine quills, which this savage was offering as a sacrifice to the falls, which is in itself admirable and frightful. I heard him, while shedding copious tears, say, addressing this great cataract: 'Thou who art a spirit, grant that the men of our nation may pass here quietly without accident, that we may kill buffalo in abundance, conquer our enemies, and bring slaves here, some of whom we will put to death before thee; the Messenecqz (Sauks and Foxes) have killed our kindred, grant that we may avenge them.'"

The significance of this prayer is understood when we recall the statements of Rev. S. W. Pond, long a missionary amongst the Sioux. According to Mr. Pond the dwelling place of the god of the waters was beneath the falls of St. Anthony. He had the form of a monster ox, and his spirit permeated all streams and lakes. He was called Oanktehi, and as his bones wer occasionally found in bogs and swamps by the superstitious natives Mr. Pond says the Indians worshipped the mastodon (or the mammoth) whose skeletons are still found in such positions. Oanktehi was the evil god, and needed to be propitiated by gifts and sacrifices. He was always contending with the thunder-bird who was the good god and presided over everything. This conflict is brought out vividly by Huggins and by Gordon in their legendary poems "Winona," and "The Feast of the Virgins."

What a setting for some painter to put upon the canvas!

Two wandering, half-starved Frenchmen portaging an old canoe along the east bank of the river.

The falls of St. Anthony just above them to the right.

The foaming rapids just below them.

A superstitious savage offering a beautiful beaver robe to Oanktehi, displaying it on the branches of an overhanging oak tree.

The rising sun in the morning sky.

The scant-forestetd hills and undulating prairies stretching from both banks into the limitless distance.

That is the psychological moment that awaits some skilful artist to be portrayed on the canvas. That is the conjunction in one great scene of the most prophetic and momentous elements in the history of Minnesota.

There is native, original Minnesota in all its untrod magnificence, pregnant with all its potential promise. There is the wild man, its sole occupant, with his feeble energy and superstitious faith.

Conjoined to these in the same scene is the tread of the first European, with all that his civilization implies. In that footstep is the embodiment of geographic exploration prompted by commerce and Christianity, the intelligence and education of Hennepin contrasted with the degradation of the savage. All the art which has followed after that scene, all the manufactures, the science, all the education, all the improved methods of human livelihood are foreshadowed and concentered in the discovery of the falls of St. Anthony. No single individual scene, no event in all our history, carries with it so much of the natural and so much of the possibility of the artificial in our history as the portaging of that canoe round the falls of St. Anthony by Father Hennepin and his companion Du Gay.

It is lamentable that in the Capitol of the state, on the wall of the governor's room, is a travesty of this scene—a painting on which the youth of the state are expected to look and from which to draw impressions of the historic discovery of 1680. When I first glanced at that painting I turned my face away in a feeling akin to disgust, and for three years I did not look upon it again. I have recently examined it, in order that I may be able to render a truthful description. As a work of art and fiction it may be worthy of praise, as a historical picture it is a misrepresentation and an abortion.

The painting shows seven persons, of whom five are seated and two are standing. Of the former one is black-whiskered Du Gay. He has a flint-lock gun, a buffalo gunpowder horn, and a game pouch suspended from his shoulder resting at his right side. He is well clothed and capped. On either side of him are four Indian warriors seated, and apparently interested in the speech which is being made by Hennepin. A red pipestone calumet lies across the gunwale of the canoe. At the right of the picture is an Indian squaw just approaching, with a bundle of baggage suspended by a head-strap, lying across her shoulders. She has Caucasian features and a copper-colored skin. It is to be inferred that the bundle belongs to Hennepin, and the squaw is a slave in his service. The bundle is nicely wrapped and strapped in what appears to be a Mackinac blanket, although it may be meant to indicate a beaver skin robe, for it is hard to believe that such an anachronism as a Mackinac blanket would by any one be introduced into such a painting. A birch canoe is on the rocks in the midst of the group, the ostensible means of travel for the whole seven.

Standing boldly to the front, and facing the falls, appears Hennepin. The spot is apparently some distance below the falls on the east bank. The point of view enables one to overlook the falls and see a small part of the river above, and hence must be supposed to be located on the brink of the gorge. At the same time it is plain that the portage round the falls has already been made and that the arrival of the squaw carrying Hennepin's baggage is the last act in the "carry." Hence it has to be inferred that the scene is at the lower end of the portage line, and at the place where they can again push their canoe into the river. This inherent inconsistency cannot be explained by any one except the artist.

The most remarkable character in this fantastic group, as is natural and was to be expected, is Hennepin himself. His cowl is thrown back upon his chasuble, revealing a shaven face and a tonsured caput. He stretches forward and upward both arms, in the left holding a crucifix as if he were proclaiming the double dominion of St. Anthony of Padua and of the king of France. A robe covers him down to his ankles. His feet are lightly sandaled, and his shoulders and back are covered with a chasuble which tapers downward to a narrow strip, extending about to his hips. The sleeves of the gown are large and flowing, and the priest's waist is girted by a twisted (or braided) heavy cord, the ends of which hang down the right side and show several ornamental enlargements. From the laborious attitude of the squaw it is evident that the whole party have but just arrived, and that the appearance of Hennepin is designed to represent him in his ordinary traveling costume, leaving it open to imagination as to what part of Hennepin's baggage the squaw carried.

The divergencies of this remarkable picture from historic truth are so glaring that the merest tyro in state history can but discern them. To the novice in state history, and to the multitudes who visit the room who know nothing about our state history it conveys a wrong impression. As a work of imaginative art it is finely executed and appropriately colored.

There is, however, a higher element in art than mere mechanical execution. True art is true to nature and to facts.

"Art is the child of nature; yes, her darling child, in whom we trace the features of the mother's face"—*Longfellow.*

In the absence of a knowledge of facts it would be warrantable to supply them, but the result ought to be labeled, not a historic painting but an imaginative restoration of history. Poems are thus built up. Novels are "based on history." Milton's "Paradise Lost," most of the dramas of Shakespeare, are of this character. But they are not history and do not claim to be history. The known events of those histories are scant or too prosaic. The poets were justifiable, in constructing their works, in supplying lacking parts.

In the case of the discovery of the falls of St. Anthony, what an opportunity for a truthful painting! the scene, the historic event, the lively description by Hennepin—the very details are all available.

Osborne Reynolds.

MINNESOTA ACADEMY OF SCIENCE VOL. IV

THE STRUCTURE OF THE UNIVERSE; BEING A PRESENTATION OF PROFESSOR OSBORNE REYNOLDS' THEORY OF GRAVITATION.

(With Experiments.)

By John Mackenzie, Minneapolis.

First Statement of Reynolds' Theory in This Country.

The title of my lecture this evening sounds high. When one talks about the structure of the universe it would seem that he has a large subject on his hands. I may also state that as far as I know what I will present to you this evening has not up to the present time been presented to or dealt with by any other scientific, philosophical or literary society in this country, and with the exception of the general mention of Reynolds' theory of gravitation by my friend Professor Henry Crew of the Northwestern University, in his recent work on "General Physics" I am not aware that the theory has yet been noticed in the United States.

Wonderful Developments of Modern Science.

Numerous and wonderful have been the discoveries of science from the time of Newton to the present day; and the end is not yet. As Henry C. Jones, Professor of Physical Chemistry in Johns Hopkins University in his work entitled, "The Electrical Nature of Matter" remarks: "It seems not too much to predict that as the 19th century surpassed the preceding 18th in the development of scientific knowledge and the discovery of truth, just so the twentieth century will exceed them all in the gifts of pure science to the story of human knowledge." I hope my lecture this evening will show you to some extent how true this is, and that indeed, already in this century the portals have been opened by the master mind of Osborne Reynolds to a new and further advance of dynamical science by the solution of the problem of all problems,—the cause of gravitation.

As To Professor Reynolds.

Professor Osborne Reynolds was born at Belfast, Ireland, on Aug. 23, 1842. He graduated at Queen's College, Cambridge, in 1867, his name being fifth in the list of wranglers in the mathematical tripos.

In 1868 he became Professor of Engineering in Owens College, Manchester, England,—an institution which is regarded as probably the greatest engineering college in the world. Owing to ill health he resigned his professorship a year and a half ago. Professor Reynolds' researches and contributions dealing with various mechanical and dynamical subjects rank very high with all engineers, and, as all students of the subject know, his researches have largely created the modern science of hydrodynamics.* The third volume of Reynold's

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* He has been presented with many honors by various scientific institutions, and his name is familiar throughout the world to all who take an interest in the physical sciences.

Scientific Works is entitled: "The Sub-mechanics of the Universe," and is published under the auspices of the Royal Society. This is a work of pure science, is highly technical, and deals wth the structure of the universe from a dyamical and mechanical point of view, and explains the cause of universal gravitation. Combining as Reynolds does the rare gifts of pure science and practical science, we get a tangible definite theory or rather explanation as to the structure of the universe, which is the result of twenty years of experimental and mathematical investigation, and which is something very different from the fruitless speculations on gravitation which have been indulged in by many of the speculative philosophers in the past. We have here at last a simple, sensible, dynamical theory of the physical universe and gravitation. The problem, however, as you will realize later, is solved by an apparent paradox.

Newton Discovered the Law But Not the Cause.

We are aware of the fact that Newton discovered and enunciated *the law* of universal gravitation, but he did not discover *the cause*. Newton proved the law by which all the material bodies in the universe were governed. This law, as you know, states that all masses of matter in the universe attract each other with forces proportional to the masses and inversely proportional to the square of the distance between them. This law governs the smallest particle of matter as well as the mightiest sun in the universe. But, while Newton *speculated* on the cause of gravitation, or the *reason why* bodies act in this way, he was unable to solve the problem. There have been many attempts since the time of Newton to solve the problem. The history of physical science is replete with the baffled efforts of the greatest intellects to find the solution. One has only to read Taylor's "Kinetic Theories of Gravitation" to realize the many fruitless attempts to solve this problem in the last two centuries, and indeed some philosophers came to the conclusion that the problem could never be solved. There are indications that Fourier and even the great Laplace considered gravitation as one of the "primordial causes" which might remain forever impenetrable to us.

The Gifts of Pure Science to Practical Science.

In the eyes of a certain class of people the many long years of toil and patient investigation of the true scientific investigator count for nothing unless they immediately bring forth some brilliant, or sensational discovery, or one which can be immediately turned into money. Some people have no use for science unless they can see immediate money in it. We should not forget, however, that the so-called "practical" fellows would very soon have nothing to work on were it not for the researches carried on and the principles discovered by the students of pure science. We have only to reflect on the practical value of Newton's discovery of the law of gravitation. This was a discovery in pure science, and has it not given the world its science of mechanics? Were it not for the mighty Newton and the great Galileo, who, out of their pure love of scientific investigation laid down the laws of motion and pure mechanics, the world could have had no engineers. And coming down to modern times, were it not for Faraday and Maxwell who discovered the principles of electric induction and electromagnetic waves there colud be no Edison or Marconi to apply them.

The Vast Apparently Empty Space of the Universe Compared to the Small Space Occupied by Matter.

When we look into the sky on a clear dark night through a powerful telescope the stars and planets appear to be set in a vast vault-like space showing the perspective of distance to a certain extent. They seem to lose the appearance which they present to the unaided eye of being set simply on a plane background. As we look into the vast abysses of space we realize that notwithstanding the great number of stars the actual space they occupy in the universe is as nothing compared to the vast spaces all round them which appear to be absolutely void. We may say that the room taken up or occupied by what we call "matter" in the universe is exceedingly small compared with the space which seems to be empty. Professor Newcomb has stated that probably there are about 100 million suns in the universe, averaging five times larger than our sun. This would give a total amount of matter of 500 million suns equal to our sun, and he supposes these suns to be equally distributed throughout a sphere 30,000 light years in diameter. In other words, light, which travels, as you know, at a velocity of 186,000 miles per second would take 30,000 years to pass from one side of such a universe or sphere to the other side. This would mean a sphere billons of billions of miles in diameter; whereas, our sun, which is something like 800,000 miles in diameter, even if enlarged 500 million times would still be but an infinitesimally small speck of matter in such a vast universe of otherwise empty space.

What is This Apparently Empty Space?

The question occurs, What is the nature of this apparently empty space? Is it a complete void or vacuum, or does it contain a medium of some kind? Now, on this point there have been many speculations. To all appearances the planets, moons, stars, comets and meteors which move through this space with great velocities meet with no resistance from this medium, if there be a medium. The earth moves through it at a speed of 19 miles per second in its journey round the sun, and recent experiments of Professor Michelson seem to prove conclusively that if there be a medium in this space none of it is entangled with the earth or carried along with the earth in its motion through space.

Another question arises: Is the powerful force of gravity which binds the different bodies of the solar system together, and in fact the whole material universe, conveyed through absolutely empty space? In other words, can momentum be transmitted across an absolute void, or is there such a thing as "action at a distance?" We know that the gravitative pull of the sun on the earth is equal to a force more than a million million steel rods, each seventeen feet in diameter could stand. The earth is 92,000,000 miles from the sun. Is this immense force transmitted across an absolute void? While the eye sees nothing in space, it would seem to our better judgment that there must be some sort of mechanism which transmits this gigantic force. Other considerations lead us to this conclusion. We know that powerful magnetic storms originating in the sun are transmitted instantaneously to the earth and throughout the whole solar system with such intensity occasionally as to put many of the telegraph instruments and wires in the country out of commission until they pass.

The Density of the Medium.

Until recent years very little of a definite nature has been known as to the nature of the medium of space. So far as any evidence it gives of its existence to our senses is concerned, it would appear to be something very unsubstantial, and for this reason it has been called the "ether." Newton had an idea that it was a very thin, highly attenuated fluid which pervaded all space, so very thin in fact, that if you could scatter a pill box full of air throughout the space of the solar system its density would then be about the density of the ether of space.

With the development of electrical science and the study of electric and magnetic forces, however, different ideas began to be entertained as to the density of the so-called ether, until to-day we have the leading physicists postulating the necessity for an ether of very high density and very much greater than the density of any known substance. In his Yale lectures on "Electricity and Matter" Sir J. J. Thomson, in discussing the nature of electrical mass, says: "The view I wish to put before you is that it is not merely a part of the mass of a body which arises in this way, but that the *whole* mass of any body is just the mass of ether surrounding the body which is carried along by the Faraday tubes associated with the atoms of the body. In fact, that all mass is mass of the ether, all momentum, momentum of the ether, and all kinetic energy kinetic energy of the ether. This view, it should be said, requires the density of the ether to be immensely greater than that of any known substance." And in his presidential address to the British Association at Winnipeg last August he said: "Since we know the volume of the corpuscle as well as the mass, we can calculate the density of the ether attached to the corpuscle; doing so, we find it amounts to the prodigious value of about 2,000 million times that of lead." He states, however, that this density would be the density of the ether only in the immediate vicinity of the corpuscle, and that its density in free space would not be so high if the ether is not compressible. Sir Oliver Lodge, in his last edition of "Modern Views of Electricity" also says: "The ether is now turning out to be by far the most substantial body known,—in comparison with which the hitherto contemplated material universe is like a vapor of extreme tenuity,—a barely perceptible filmy veil."

These conclusions of Thomson and Lodge as to the density of the medium of space are arrived at by the study of electromagnetic and electrostatic forces. Professor Reynolds works out his conclusions from mechanical and dynamical considerations, and arrives at the density of the medium of space as being ten thousand times that of water, or 480 times denser than platinum, which is the densest matter on earth.

In view of this great density of the medium of space, does it not seem rather paradoxical that what we call matter, that is, the planets, suns, moons, comets and so forth, which are so much less dense than the medium should move through the medium apparently without resistance and at such high velocities? Our earth, as you know, moves in its orbit at a velocity of 19 miles per second. You have all seen bubbles moving in water. Reynolds shows that the earth and all the other material bodies move through space in a similar manner. They are less dense than the medium in which they exist, and, as we shall see, their movements are due to differences of pressure in the surrounding medium. They are like so many filmy soap bubbles which a child blows from the stem of a pipe. Real mass is not in the material things which we see, but in space where the eye sees nothing. The sober conclusion of the most advanced dynamical science is that matter is a negative thing so far as its mass is concerned, and that the space occupied by "matter" contains very much less mass than the space where no "matter" exists.

Is the Medium Continuous or Granular?

We now come to another important point. I have here on the table a glass full of small shot and another glass full of jelly. The glass of shot we will take to represent a universe composed of what we will call a "granular medium," that is, a medium composed of discrete or separate parts or grains; the jelly represents a universe composed of what we will call a "continuous medium," that is a medium not made up of discrete or separate parts, but continuous in its structure. These two kinds of structures represent the two views which are held as to the nature of the structure of the medium of space. We have ascertained that this medium is very dense; now let us endeavor to find out the character of its structure. On the correct answer to this question hinges the true solution of the problem of gravitation.

We have had atomic systems of philosophy from the earliest ages. Democritus and Lucretius are the ancient fathers of the atomic systems. In his great poem on the origin of things Lucretius speculates on the atomic system of the universe, and tries to show that the origin of the universe was due to a "concourse of atoms." There have been many speculations on this point from that day to this; but it has remained for modern science, with its experimental and mathematical methods, to arrive at the truth.

Analogy would suggest that the medium of space would be granular in its structure. We are not acquainted with anything that cannot be divided into parts. The atomic theory in chemistry, whose modern founder was Dalton, and which has proved so fertile, postulates that the chemical unit is the atom, and that the atom is the unit from which is built up systems of molecules, organic and inorganic, in the universe around us; that all things are combinations and compounds of atoms. The atom, indeed, has been weighed and measured. Maxwell and Kelvin did this for us, and we know in fact about how many atoms could be laid alongside each other in the length of an inch. They tell us that from ten million to one hundred million atoms could be laid alongside each other to make up an inch in length. Of course, anything so small as this is inconceivable; but we know that the inconceivability of a thing now-a-days does not mean that it is impossible. Kelvin stated that if a drop of water were enlarged to the size of the earth, which we know is about 8,000 miles in diameter, the atoms or molecules of which it is composed would appear about the size of base balls.

In recent years, however, somethng very much smaller than the atom has been discovered by science. You have all heard of the electron. An electron is an atom of electricity. It is now maintained by physicists that the ordinary chemical atom which I have just spoken of, is a compound thing, and is composed of aggregations of thousands of electrons. An electron has been defined as an "electric point charge" in the ether. It seems to be an almost infinitely small point of electricity, and the idea is that aggregations of these electric point charges or electrons, when combined into a system form what is known as the chemical atom. Configurations of such a system have been worked out by Thomson, Larmor and others, and it would appear that the system of the chemical atom which is an aggregation of electrons is far more complicated than the solar system. The infinitely small is turning out to be more complex than the infinitely great. The universe within the atom seems to be more complicated than the universe outside. The electron is, of course, very much smaller than the atom, and, like the atom, its size is inconceivable. One may get an idea of the size of the electron as compared with the size of the atom if we suppose the electron to be about as large as the head of a pin revolving inside the Minneapolis Auditorium, the Auditorium being taken to represent the size of the atom. These electrons which make up the atomic system move with very high velocities in the atomic system. The mass of the moving electron has been measured, as well as the electric charge which it carries.

So we see that by the discovery of the electron we have simply discovered a smaller kind of atom than the old chemical one. The electron theory, then, still maintains the granular structure of the ether or medium of space. I ought to say, however, that there are still some physicists, notably, Sir Oliver Lodge, who seem to maintain that the medium of space is not granular or of a discrete structure, but that it is a "perfectly continuous, incompressible and inextensible medium filling all space without interstices or breach of continuity." The continuous medium theory, however, has so far completely failed to give the slightest clue to the cause of gravitation, and all that Lodge has to say is that "gravitation is explicable by differences of pressure in the medium, caused by some action between it and matter not yet understood." He is right in saying that it is caused by differences of pressure in the medium, but he cannot find the proper mechanism to produce these necessary differences of pressure in his continuous medium.

By an elaborate analysis Reynolds shows that the medium of space must be granular in its constitution. He shows that space is occupied by uniform spherical grains of changeless shape and size. It is occupied by what he calls "spherical grains in normal piling." The opening statement in his "Sub-mechanics of the Universe" is:

> "By this research it is shown that there is one and only one, conceivable purely mechanical system capable of accounting for all the physical evidence, as we know it, in the universe."
>
> "The system is neither more nor less than an arrangement of indefinite extent, of uniform spherical grains generally in normal piling so close that the grains cannot change their neighbours, although continually in relative motion with each other; the grains being of changeless shape and size; thus constituting to a first approximation, an elastic medium with six axes of elasticity symmetrically placed."

It is worthy of note that Newton also had the conception that the real sub-stratum of the physical universe is granular in its structure, for in the fourth edition of his "Opticks" page 375 he says: "All things considered, it seems probable that God in the beginning formed matter in solid, massy, hard, impenetrable, movable particles, of such sizes, figures and with such other properties, and in such proportion in space as most conduced to the end for which he formed them, and that these primitive particles being solids, are incomparably harder than any porous bodies compounded of them; even so very hard as never to wear or break to pieces; no ordinary power being able to divide what God himself made one in the first creation."

The question has been asked, why are most sports but the variants of one object, the propulsion of a sphere? Billiards, baseball, polo, golf, slinging, marbles, squash, handball, football, racquets, cricket, hockey, bagatelle, tennis, shooting, pelota, all have as their basic pursuit the driving of a ball, the propulsion of a sphere. Tipcat, shuttlecock and top spinning are the employment of modifications of the sphere. May the reason not be that poor mortal man attempts by these means to get in a small way into the tremendous scheme of the universe, which is the everlasting movement of the spheres?

The Fundamental Atom.

We considered above the size of the chemical atom and also the approximate size of the electron, aggregations of which, according to the electron theory make up the chemical atom. We saw how very small the electron is as compared with the chemical atom. We shall now enquire as to the size of the grain in Reynolds' granular medium. Reynolds shows that its diameter is the seven hundred thousand millionth part of the wave length of violet light. A wave of violet light is about the 70 thousandth part of an inch in length. Reynolds' cosmic grain, then, is very much smaller than even the electron. It is at least as much smaller than the electron as the electron is smaller than the chemical atom, the sizes of all three being equally inconceivable. This cosmic grain of Reynolds is the absolute or fundamental atom of the universe. It is the smallest entity which can exist in space. Reynolds has shown by dynamical and mathematical considerations that this grain is the smallest possible entity which can exist in the universe. It is the "absolutely rigid granule, ultimate atom or primordian." In Section VIII. of the "Sub-mechanics" he says:

> "Although the absolutely rigid atom is as old as any conception in physical philosophy, the properties attributed to it are outside any experience derived from the properties of matter. In this respect the perfect atom is in the same position, though in a different way, as that other physical conception—the perfect fluid. Both of these conceptions represent conditions to which matter in one or other of its modes, apparently approximates, but to which, the results of all researches show, it can never attain, although this experience shows that there is still something beyond. * * * It becomes clear therefore that any fundamental atom must be considered as something outside—of another order than—material bodies, the properties of which are not to be considered as a consequence of the laws of motion and conservation of energy in the medium, but as the prime cause of these laws."

This last statement involves a very important principle; for, whereas other theories of the atom have been based on the motion of a so-called perfect fluid continuously filling space, like Kelvin's vortex atomic theory, or upon an electronic system of electrostatic and electromagnetic forces, as developed by Thomson, Larmor and Lodge, the atom in these systems being the *result* of the laws of motion and conservation of energy, Reynold's fundamental atoms or cosmic grains, by their *motions and arrangements* are themselves the cause of the laws of motion and conservation of energy, the whole explanation and philosophy being purely dynamical, just as Newton's explanation of the law of gravitation is purely dynamical.

Arrangement or Piling of the Grains.

We come now to one of the most important points in the whole subject; that is, the arrangement or piling of the grains in the medium. We have all doubtless seen cannon balls piled in heaps on military reservations. Now, there are different ways in which shot or other spheres may be piled. I have here before me on the table six different regular arrangements or piling of small rubber balls, and in these different arrangements the number of balls varies in proportion to the total volume or space occupied by the balls. There are six regular arrangements in which balls touching each other may be piled, shown by these six models, and in each of these arrangements, as stated, the full spaces or the spaces occupied by the balls, and the empty spaces or the interstices between them vary. I have calculated the relation or proportion of full space to empty space in these six different arrangements, and find that in the closest arrangement or piling, where the grains are arranged in parallel tiers in triangular form, taking the total volume of the pile as 100, the full space occupied by the balls amounts to 79.818 and the empty space to 20.182, or about 4 to 1, whereas in the most open arrangement of piling, where the grains are placed vertically over each other in parallel tiers in the square position, like this model, the full space is only

52.381 and the empty space 47.619, or about 11 to 10. The other four methods of piling lie between these two extremes. I append to this lecture the figures of the proportions of full space to empty space in the six arrangements.

One of Reynolds' most inportant steps toward the discovery of the cause of gravitation was the discovery of the dilatancy of granular media under pressure. For instance, when shot or sand or other spherical grains are put into a bag or other closed surface and shaken, they settle into a very close position, and when in this position the spaces or interstices which exist between the grains are about the smallest possible. They may then be said to be in what Reynolds calls "normal piling" and when in this position the shape of the bag containing the shot or grains cannot be changed without at the same time changing its bulk or volume; because if you endeavor to change the shape of the containing vessel under such conditions, you are at the same time disturbing the grains from their closest possible positions into another arrangement less close, whereby the spaces or interstices between the grains are enlarged, thereby producing a vacuum, or working against atmospheric pressure. I have here two hollow rubber balls, one filled with small shot and completely closed, except for a small opening which does not allow the shot to escape, and into which a glass tube is inserted to measure the dilatation. Colored water is poured into the bag through the tube to fill the interstices between the shot, and if the bag is then subjected to distortional squeezing, as it now is, the water, as you see, sinks in the tube. It is drawn into the bag to fill the expanded spaces between the grains caused by the distortion. This is an experimental model universe. I have here another similar bag filled only with water, but, as you see, when it is similarly squeezed the water rises in the tube. I have here also one of these thin rubber balloons which children play with, filled with sand and just enough water to fill the interstices between the sand when lying flat as you see it now. It is closed tightly so as not to admit any air. It is now placed on its edge, and, as you see, sustains a weight of 200 pounds without flinching. This appears to be nothing short of magical, but when the phenomena of dilatation of granular media under pressure is understood it is perfectly simple. (Experiment.)

This remarkable property of dilatancy of all granular media was discovered by Reynolds. It also furnished him the clue to the cause of gravitation. In order to get granular media under pressure it must be bounded by a closed surface. Reynolds says: "If, as in the universe, the grains in normal piling extend indefinitely, there can be no mean motion of the boundaries, whatever the pressure may be; and thus the grains are virtually within a closed surface."

Here is a model made out of small rubber balls of the way the cosmic grains are arranged in space according to Reynolds. This arrangement is what he calls "normal piling," and is such that the grains are placed in a set of squarely formed layers horizontally, each sphere resting on four in the layer below, and in its turn supporting four in the layer above, these last four being vertically over the first four. Besides touching these eight in adjoining layers it touches four in its own layer, making twelve in all. There are therefore twelve grains piled around each grain. This then is the arrangement or piling of the grains throughout the universe of space where no matter exists.

Matter is Absence of Grains.

Where matter exists there is a different arrangement in the piling of the grains, and the regular or normal piling of the grains is broken. There is a less number of grains per unit volume in the spots where matter exists than there is in the regular medium of space. Where this deficiency which results in what we call "matter" exists, there is what Reynolds calls "abnormal piling" of the grains. This deficiency forms a sort of crack, or gap, or loose joint in the medium, and there is a break in the gearing of the grains between the matter and the medium outside. An atom of matter consists of a nucleus of grains in normal piling surrounded by a surface or spherical shell of grains in abnormal piling. The grains in abnormal piling form what Reynolds calls "a singular surface of misfit" between the regular piling inside, which forms the nucleus of the material atom and the normally piled grains of the medium outside. This "surface of misfit" or spherical shell together with its nucleus is called a "negative inequality" and the magnitude of the negative inequality is reckoned by the number of grains which are deficient, and as the number of grains present in a given volume of the medium determines the mass of the medium, an absence of grains means an absence of mass. Therefore, matter is absence of mass or negative mass. These surfaces of misfit or spherical cracks in the medium are places of weakness in the medium, and it is shown that they travel through the medium after the manner of solitary waves.

Mean and Relative Motion of the Medium.

We have now to consider whether the grains of the medium are fixed and stationary in their places, or whether they have motion among one another. Reynolds shows that the grains of the medium are not fixed but that they have a mean and relative motion. The medium is not inert and rigid and lifeless. It thrills with energy and pulsates with universal motion. It possesses two kinds of motion, first, the relative motion of the grains among one another, and, second, a mean motion, which is a motion of the mass of the medium as a whole from one position in space to another. The average relative velocity of the grains among one another is shown to be about one and one-third feet per second, while the mean path of the grain, that is, the average distance a grain has to move before it strikes its neighbor, is shown to be the four thousand millionth part of the diameter of the grain. It is the relative motion of the grains among one another which renders the medium elastic, and, as Reynolds says, is the prime cause of elasticity in the universe. The mean and relative motions of the medium are illustrated by the movement of a cloud of dust, a swarm of bees, a shower of hail, a current of air, a stream of water, or a cloud in the sky. In each of these phenomena we have movement of the mass of the particles as a whole and also the individual movement of the particles of which the mass is composed with relation to each other. The movement of the mass as a whole is called the mean motion, and the relative movement of the particles in the mass is the relative motion of the medium.

The Pressure and Stress of the Medium.

Let us now ask, What is the pressure of this medium of space? We certainly do not feel its pressure; neither do we feel atmospheric pressure, though we know that the atmospheric pressure on the surface of the earth at sea level is nearly 15 pounds on the square inch. At great ocean depths we also know that the hydraulic pressure amounts to several tons per square inch; and we also know that as we go down into the earth the pressure of the surrounding rocks and strata increases very rapidly, until at great depths it amounts to hundreds of tons on the square inch. We probably do not realize that every square foot of surface of a man's body is subjected to an atmospheric pressure of about one ton, so if the surface area of a human body is say 10 feet, that body is subjected to a total pressure of about 10 tons. We are ordinarily unconscious of such a pressure, because it presses upon us equally in all directions, but if this pressure should be suddenly removed from one side of our body we would soon realize it, and the pressure on the other side would hurl us through space with the speed of a cannon ball.

Located as we are on our tiny earth, which is whirling through infinite space at a speed of 19 miles per second, we are immersed in a vast ethereal ocean. Can we ascertain whether the medium of this ocean has any pressure? Reynolds shows that the mean pressure of the medium of this universal ocean of space is nearly seven hundred and fifty thousand tons on the square inch, being more than three thousand times greater than the strongest material can sustain. A statement like this seems paradoxical, and we cannot by any stretch of the imagination conceive of such a pressure existing in what we have hitherto regarded as empty space. Yet such is the sober truth, found necessary to account for the physical facts that we know. Clerk Maxwell, the great Scotch mathematician and physicist, arrived at the same conclusion as to pressure and stress of the ether from a consideration of electromagnetic and electrostatic forces. In his article on "Attraction" in the Encyclopoedia Brittanica, after discussing this subject, he says: "The state of stress, therefore, which we must suppose to exist in the invisible medium is 3,000 times greater than that which the strongest steel could support."

Now it seems rather strange to us at first that the medium of space is of such great density. We have been accustomed all our lives to think of matter as being in fact the only solid reality, and universal space as simply nothing. It will thus be seen that the old style philosophical materialist will find slight comfort in Reynolds' theory, for the materialist's so-called real matter is shown to be only a kind of froth or foam or bubble in the universal granular ocean, which is ten thousand times denser than water. The presence of what we call "matter" in space means a place where there is a sort of crack, a gap or fissure in the uniform medium. It may be interesting here to mention Kelvin's vortex atomic theory of matter, from which so much was expected, but which has failed to give any clue to gravity, and any theory of matter which does not contain a solution of the problem of gravitation can have no permanent value, for gravitation is the supreme problem before physics to-day. The next great advance in physical science lies in the solution of this problem.

The Vortex Atomic Theory.

Kelvin conceived a perfect fluid continuously filling space, and he supposed that what we call an atom of matter is the rotating portion of this fluid. We can make air, water or any other fluid more or less rigid by imparting rapid motion to it. The motion differentiates that portion of the fluid which is in motion from that portion which is not in motion, like the smoke ring which sometimes ascends from the funnel of a locomotive. The idea was that if the fluid were frictionless and vortex motion once started in it that motion would continue forever. He conceived that atoms might be composed of such rings of ether in motion, the ether being supposed to be the perfect fluid. The atoms were a sort of ether squirts. This theory of matter was quite interesting and something new at the time, and the dynamics of the theory were worked out by Helmholtz and J. J. Thomson, but notwithstanding that it promised so much, it has been for the most part given up, and it has not been able to throw any light on the problem of gravitation. I spoke about the electron theory of matter in a previous part of this lecture. Neither has this theory, however fascinating in many respects, been able to produce an explanation of gravity. The gravitational force is entirely different from and belongs to another order than the electrostatic and electromagnetic forces, and all the endeavors to get an explanation of gravitation out of them have led to negative results.

Mass.

We have spoken about mass. Now let us see what mass is. Of course, mass has been defined as the amount of matter in a body, or the inertia of a body. We should not confound mass with weight. The book which is lying on this table has a certain weight here which can be ascertained exactly, but if I transferred it to the Equator of the earth it would weigh less than it does here, and if I took it to the North Pole it would weigh more. In other words, the weight of a body on the earth's surface depends on its distance from the center of the earth, and *vice versa*, and we know that the surface of the earth at the Equator is 13 miles further away from the center of the earth than the North Pole is. But the book at any place on the earth's surface would still have exactly the same mass, and indeed it would still have the same mass at any place in the universe. Weight depends on the force of gravity, and we know the force of gravity varies at different points of the earth's surface, according to their distance from the earth's center; but the mass does not vary so long as the law of the conservation of matter holds good. If the book were placed millions of miles from the earth away out in interstellar space where there was no planet or sun to attract it, it would remain suspended in space without motion, and would have no weight; but its mass would be the same as before. How is this? Because it would require exactly the same amount of force to move it over a certain distance in a certain time. Mass is measured by the amount of force required to move it over unit distance in unit time, and unit mass is that quantity of mass which is moved unit distance in unit time by unit force, no matter in what part of the universe it may be placed, whether it may be on earth, or on the planet Mars or Jupiter or billions of miles away in interstellar space. But this only gives us a measure of mass. It does not tell us what mass is. It is only in recent years by the study of X rays, cathode rays, and other electrical discharges in the Crookes' tube that physical science has been able to gain some definite knowledge on this subject. As I stated in a previous part of this lecture, a good deal is now known about the behaviour of the particles, called electrons or corpuscles, which make up the discharge which passes from the negative to the positive pole of the tube. The mass of these particles, the electric charge which they carry, and the velocity with which they travel have been measured. These particles may be called electric points, or electric point charges, and it is found that their mass is not a constant quantity, but that it varies with the speed with which they travel in the tube. As their velocity is increased their mass becomes greater, as it is diminished their mass becomes less; so that their mass is a function of their velocity. They have no mass apart from motion. This being the case, their momentum is also a function of their velocity, as is also their energy, for momentum is the product of mass and velocity and energy the product of mass and the square of the velocity. I spoke about the electrons which whirl around inside the system of the atom with very high velocities, in some cases with nearly the velocity of light. Calculations have been given by Sir J. J. Thomson showing the enormous amount of electronic energy due to the motions of the electrons inside the atomic system. It is found that inside the atoms of one gram of hydrogen gas there is contained an amount of electronic or corpuscular energy, which if set free, would be sufficient to raise one million tons 300 feet high. We know the energy which is liberated in an explosion of dynamite or guncotton. That is atomic energy, caused by what we call chemical affinity. But we see how much greater sub-atomic energy is. Perhaps the day will come when man will know how to set free this sub-atomic energy, but for the present it is probably better that he does not know.

Negative Inequalities.

The ordinary chemical atom, then, seems to be a sort of hole or sink or hollow place in some medium which fills space, and to be a locus or point into which pours tremendous energies from this medium. This hole or sink or hollow place in space which is the locus of the atom is what Reynolds calls a "negative inequality" in the medium, or a "singular surface of misfit" due to a deficiency of grains below the number in the regular normal piling in the surrounding space. He calculates that the real core of the atom consists of the normally piled grains, and that this normally piled core is surrounded by a spherical shell containing a deficiency of grains, the thickness of this spherical shell being probably about five times the diameter of the grain. This spherical shell is surrounded on the outside by the normally piled grains which extend outwards into space indefinitely. Wherever these spherical negative inequalities exist, however, there is set up in the medium surrounding them a system of strains due to the pressure of the medium, which result in producing a curvature in the normal piling of the medium.

I will now try to show how the motion of these negative inequalities which we call matter is possible in such a medium, and how these negative inequalities gravitate toward each other through the medium according to the law of gravitation. How does matter move through space? How does the earth move through space at the rate of nearly 20 miles per second? Reynolds' solution of the problem is very interesting. It moves by propagation. He compares it to a bubble rising in water. He says: "* * * it follows as two negative centers approach each other under their mutual attractions the mass in the medium recedes, which is an inversion of the preconceived ideas. Such action however is not outside experience, since every bubble which ascends from the bottom of a glass of soda water involves the same action. The matter in the bubble having the density of air requires the descent of an equal volume of water at a density 800 times greater than that of air. It is the negative inequality in the density of matter, which under the varying pressure of the water causes the negative or downward displacement of the material medium—water and the positive or upward displacement of the negative inequality in the density within the singular surface."

Propagation of "Matter" Through Space.

I have here a dozen billiard balls, divided into two rows of half a dozen each close together, one row a little higher than the other and resting in a continuous groove, so the upper ones may run down and strike the lower ones. There is a gap of say 18 inches between the two rows. We allow the upper six balls to run down and strike the end of the lower six one by one. The result will be that as each ball from the upper row strikes the end ball of the lower row the ball at the far end of the lower row will run away from the lower row the moment of the impact of the ball from the upper row, and it will run away with the same speed as the speed of the impinging ball which strikes the front end. In other words, all the motion or momentum of the striking ball will be communicated through the whole row of lower balls instantaneously and will be delivered to the last ball, which will carry away the motion or momentum. Meantime, as each ball runs away from the rear end and one comes in in front the whole six balls have run down and taken up their positions in front, delivering their momentum to the lower row, the whole row of lower balls will have moved forward its entire length, or six diameters. This illustrates how positive and negative momentum may move through a body at the same time in opposite directions, for as each ball strikes the front end it communicates a certain amount of positive momentum to the mass as a whole, which travels through the mass in a positive direction, and an equal amount of momentum travels through the mass in an opposite, or negative direction, which results in the motion in the opposite direction of the mass as a whole. The real motion of the mass is in the opposite direction to that of the impinging balls. If the balls moved quick enough the eye would lead us to suppose that the motion of the lower row of balls was continuous, and not done by successive impacts, just as in moving pictures which appear to represent a continuous scene, but which we know is made up of a multitude of separate scenes taken in rapid succession. We may take the gap between the two rows of balls to represent the inequality which is to propagate through the medium, for instance the earth moving through space. There is an incoming of grains in front and a leaving of grains in the rear, the momentum of the incoming grains being transmitted instantaneously throughout the whole mass from front to rear, the real mass of the medium moving in the opposite direction to that of the inequality. Reynolds says: "If the medium is stationary and the molecules are moving with the earth the grains within the surfaces do not partake of the mean motion of these surfaces, being replaced continuously by other grains by the action of propagation, by which the singular surfaces in their motion are continually absorbing the grains in front and leaving those behind without any mean effect on the motion of the grains. And thus there is perfect freedom of the molecules or aggregate matter, although the grains which constitute the nuclei are changing at the rate of 20 miles a second. To be standing on a floor that is running away at a rate of 20 miles a second without being conscious of any motion is our continual experience, but to realize that such is the case is certainly a tax on the imagination. Such motion has all the character of a wave in the medium, and that is what the singular surfaces which we call matter are—waves. We are all waves."

Cause of Gravitation.

We now come to what is really the most important part of our subject, namely, the cause of gravitation, and if you have been able to comprehend what has already been stated, I think you will have no trouble in understanding what is now to be explained, that is, why two bodies or masses of matter in space may approach each other according to the Newtonian law of gravitation.

In the first place we must rid our minds of the idea that there is any such thing as "attraction" inherent in masses of matter themselves. Though in popular language we speak about the sun attracting the earth, the earth attracting the moon, etc., in reality they do not attract each other. All motions are really produced by pressure of some kind or other exerted upon the bodies which move. Air currents, ocean currents, the tides, as well as movements of rigid bodies are produced by pressure exerted in some way, and the gravitation or motion of bodies in universal space is no exception to this. Reynolds shows that wherever these "negative inequalities" or "singular surfaces of misfit" which we have seen to be matter, exist, there we have a sort of gap or crack in the granular medium, which forms a surface of weakness, and it is shown that the pressure of the medium is less between these "negative inequalities" or surfaces of weakness than it is on the outside. There is a strain set up in the granular medium in normal piling between them, which produces a curvature in the normal piling. This produces space variations or dilatations between the grains in the curved normal piling. These spaces vary according to the degree of the curve, and the total of the enlarged spaces or dilatations so produced by the curvature is exactly equal to the total of the spaces from which the grains are absent in the negative inequalities which produce the curve. Owing to this, as has been said, the pressure of the medium is less between the negative inequalities or masses of matter than it is in the medium outside, with the result that the extra outside pressure drives the negative inequalities together. The old physics calls this "space variation of the potential." As the bodies approach the curvature is annihilated and the medium is restored to the regular normal piling.

It is somewhat difficult at first for one to understand this process; but the dynamical reasoning upon which it is based is thoroughly sound. Reynolds says: "This law of attraction, which satisfies all the conditions of gravitation, is now shown by definite analysis to result from negative local inequalities in an otherwise uniform granular medium under a mean pressure equal in all directions, as a consequence of the property of dilatancy in such media when the grains are so close that there is no diffusion and infinite relative motion and further it is shown to be the only attraction which satisfies the conditions of gravitation in a purely mechanical system."

"Gravitation is not the result of that dilatation which results from uniform *parallel* strains in the medium in normal piling, but results solely from those components of the dilatations caused by the *space variation of the inward strains.*

"Thus, as long as the dilatation strains are parallel there is no attraction; but if there is curvature in the strains there will be efforts, proportional to the inverse square of the distance, to cause the negative inequalities to approach from a finite distance.

"Thus gravitation is the rsult of those components of the dilatations (taken to a first approximation) which are caused by the variations of the components of the inward strains, caused by curvature in the normal piling of the medium.

"The other components of the strains, being parallel distortions, which satisfy the conditions of geometrical similarity, do not affect the efforts.

"Then, since if the grains were indefinitely small, while the curvature in the normal piling was finite, there would be no effort. And multiplying this parameter by the curvature of the medium, and again by the mean pressure of the medium, the product measures the intensity of the efforts to approach.

"The dilatation diminishes as the centres of the negative inequalities approach, and work is done by the pressure outside the singular surfaces, to bring the singular surfaces of the negative inequalities together.

"The efforts to cause the approach of the centers correspond exactly to the gravitation of matter if matter represents the absence of mass, and thus the inversion of preconceived ideas is complete. Matter is measured by the absence of mass necessary to complete the normal piling. And the effort to bring the negative inequalities together is also an effort on the mass to recede; and since the actions are those of positive pressure, there is no attraction involved, the efforts being the result of the virtual diminution of the pressures inwards, and in this inversion we have a complete, quantitative, purely mechanical explanation of the cause of gravitation.

"The mechanical actions on which this attraction depends are completely exposed in the foregoing analysis, and offer a complete explanation of the cause of gravitation."

Positive Inequalities.

In addition to their being "negative inequalities" in the medium or places where there is an absence of grains, there may be places where there are a greater number of grains than exists in the normal piling, and such places are called "positive inequalities" in the medium. In these cases the curvature which will exist in the normal piling between two "positive inequalities" will be the reverse of the curvature in the case of two negative inequalities, producing a repulsion between two such positive centers, which will drive such positive inequalities or centers away from each other, just the opposite of gravitational attraction. There would, therefore, be no evidence in the universe of such positive inequalities, as through the force of repulsion they would be scattered to the remote regions of the universe.

Other Phenomena Explained.

What is electricity? Reynolds explains that electricity is due to what he calls a "complex inequality." That is, a certain cluster of grains may be by some means moved from one position in space to another, and a current of electricity is a flowing back of these grains to their former positions. Calculations are given to show that the efforts to revert in the case of such complex inequalities correspond to electricity.

Magnetism is due to rotational stresses in the medium between spherical clusters and surrounding grains, the stresses being opposite ways round in different portions. The strains accompanying these rotational stresses involve dilatation, and attractions and repulsions will be exhibited.

The theory also explains other physical phenomena, such as cohesion, light, heat, aberration, refraction and polarization of light, the association and dis-sociation of molecules, the dispersion of the spectrum, and other natural phenomena. Reynolds says: "Considering that not one of these phenomena had perviously received a mechanical explanation it appears how indefinitely small must be the probability that there should be another structure of the universe which would satisfy the same evidence."

Steps Taken By Reynolds.

Some may ask, if Reynolds' theory is such a great one why is it that we do not hear more about it? Also what does the scientific world think of the theory? In answer to the first question I may say that there has scarcely yet been time since the publication of Reynolds' work for the theory to become known. The "Submechanics of the Universe" was published in 1903, but the mathematical difficulties of the work are so great, that few are able to grasp the proofs. Neither are all the proofs of the theory in this work. The final theory is the result of five successive steps or discoveries. These steps or discoveries were made, as Reynolds says, "apart from any idea that they would be steps towards the mechanical solution of the problem of the universe." These steps and discoveries are to be found in Volumes I. and II. of Reynolds' Scientific Papers. The first of these steps was taken in 1874, the second in 1879, the third in 1883, the fourth in 1885, and the fifth in 1895. Each deals with a particular physical problem, and taken altogether they form the base on which the great superstructure, "The Submechanics of the Universe" is built. I append to this lecture the names of the subjects dealt with in the five successive steps referred to. So it need not be a matter of surprise that more is not heard of the theory yet.

Solved By A Paradox.

In addition to this the ideas which flow from the theory seem at first strange to our minds and to our preconceived ideas, and it is only by rational analysis that we can arrive at the conceptions which the theory contains. The solution of the problem of gravitation seems to be solved by a paradox. Yet this should not deter us from attacking it. The history of science rather proves that every intellectual advance realizes a paradoxical opinion, and that "intellectual development may be traced to the successive discomfitures of common sence." Who ever believes progress to be as certain in the future as it has been in the past, must admit, *a priori* the existence of phenomena which conflict with what we know at present, and from the fact that man's knowledge about the world has received continual additions, it immediately follows that to *every time* other truths are given than those hitherto demonstrable. Every generation has supposed that it stood on the apex of the pyramid, and has supposed all phenomena of nature to be deducible from just those laws known to it, so that all future generations had the mere subordinate task of dragging new stones on to a structure of which the architectural conception was complete. But true progress is not extensive but vertical, and so it has always been such investigators as were free from this prejudice who have been destined to make revolutionary discoveries.

The history of knowledge is like the development of a mine. When the ore has been worked out down to one level a new level must be started deeper down. The ore on one level will only last a certain time, and if we would keep enlarging the mine the explorations must go to deeper levels. In like manner in the history of science we find that science reaches a certain stage under the domination of some reigning method or idea, and that it is then unable to go any further until a new discovery is made, or until the mine of knowledge is tapped, as it were at a deeper level. This gives science a new impulse and new ideas and knowledge flow from such discovery. Such for instance were the great discoveries of Copernicus and Newton, and I think that Reynolds' theory of the cause of gravitation is destined to be another epoch making discovery. It is an inversion of ideas hitherto conceived as to matter and mass, from which will probably flow a series of wonderful discoveries as to the true mechanism of the universe in which we live.

Reynolds' explanation of the motion of matter through space is in itself a new and most wonderful conception. It takes place by propagation. Propagation means generation, renewal. The motion of the earth through space is not a *bodily translation*, but the movement of a form or wave having the shape of the earth, by means of an exchange of momentum between the cosmic grains on opposite sides of the surface, just as the gap between the two rows of balls in the experiment which you saw, moves forward as the balls pass across from one surface to the opposite one. The gap between the two rows of balls is the "negative inequality," which we call "matter." Reynolds puts it: "Thus it is that the inequality in density, the integral of which is the volume of the grains, the replacement of which would restore the uniformity of the medium, obliterating the inequality, constitutes the mass propagated. And as this, for a negative centre is negative, its propagation requires the displacement of an equivalent positive mass in the opposite direction to that of propagation of the negative inequality." This is the supreme paradox of the whole theory, and leads to an inversion of ideas as to the structure of the universe. It would strike us as chimerical were it not established by sound mathematical and dynamical investigation. Remember also the statement of Sir J. J. Thomson, arrived at from another line of investigation that "all mass is mass of the ether, all momentum, momentum of the ether, and all kinetic energy kinetic energy of the ether. This view, it should be said, requires the density of the ether to be immensely greater than that of any known substance."

From these new views and conceptions I look for great developments in philosophy in the near future.

Notices of the Theory.

In regard to the scientific world, the theory has scarcely as yet entered the stage of criticism. There have been some notices of the theory in England. The "Sub-mechanics of the Universe" was published in 1903. Whetham in his "Recent Development of Physical Science" published recently, referring to Reynolds' work, says: "The mathematical analysis by which these deductions are established is attempt will stand the criticisms that will be directed against it; but very complex and difficult, and it is yet too soon to say if this bold

Professor Osborne Reynolds' great reputation and the twenty years he has labored at this research will ensure for it a careful consideration from those competent to judge of its merits."

Professor J. D. Everett, at the end of an article on "Normal Piling" published in the Philosophical Magazine, says: "I have not made any attempt to verify the elaborate statistical calculations with which Professor Reynolds' paper abounds. My present purpose is not controversy but explanation, and the style of the paper is so exceedingly technical that a good deal of explanation seems to be necessary before an intelligent controversy can begin. I have chiefly aimed at an explanation of the geometrical conditions which underlie the system supposed, thereby clearing the way for more searching criticism, and helping towards the working out of the very fruitful suggestions which the theory contains."

Professor G. H. Bryan, in a review of Reynolds' work in "Nature" concludes by saying: "It may safely be described as one of the most remarkable attempts that have been made in recent years to formulate a dynamical system of accounting for all the physical phenomena at present known. A theory such as is here set forth may not improbably play the same part in modern science that was assumed by the atomic theory and the kinetic theory of gases in the science of the time when these theories were propounded. It may be confidently anticipated that Professor Osborne Reynolds' granular medium will play an important part in the physics of the future."

Influence on Philosophy.

What will be the influence of Reynolds' theory on philosophy? So far as this is concerned I think it is destined to play a very important part in philosophy. Previous systems of philosophy have been very ignorant as to the structure of the universe. They have been composed mostly of metaphysical guesswork. Philosophy requires the aid of positive science to explain the fundamental arrangement of the universe; and hitherto no medium has ever been suggested which would cause a statistical force of attraction between two bodies at a dinstance. The explanation of gravitation as enunciated by Reynolds carries with it probably the greatest scientific conception that has ever entered the mind of man, and any philosophy of the future which has any pretentions to arrive at the truth must take Reynolds' theory into consideration. Notwithstanding all the great systems of philosophy which have been spun from the brain of man throughout the ages, not one of them has been able to explain the simplest and most familiar phenomenon, viz., the fall of a stone to the ground. Ever since man has been upon the earth he has seen the phenomena caused by gravitation. He has seen the avalanche hurtling down the mountain side, the rivers rolling onward to the sea, and countless other phenomena caused by gravity which happened daily before his eyes. To the astronomer every movement of the heavenly bodies is caused by gravity; the geologist has constantly before his eyes evidences of its action in the formation of the earth, and the physiologist sees its action in the structure of our bodies; in short, there is not a single department of nature where gravity has not played a most important role. It is the most universal agent known. And, notwithstanding all this does it not seem strange that its cause has remained unknown until now? Yet, this need not surprise us; for the predominant characteristic of man is, and has always been his ignorance of the things concerning himself and nature around him. Taking the history of mankind as extending over several thousand years at least, we may say that it was only yesterday that he learned that his blood circulated in his body, that the atmosphere had weight, and that the earth went round the sun. With the liberation of man's mind through the aid of science he is now beginning to realize something of his own possibilities, and to cast a prophetic eye towards the future, which holds within its womb possibilities for him yet undreamed of, as the fruit of his knowledge. Man's mind is not yet exhausted. It is only beginning its career of conquest over nature.

Dr. Carl Barus in his "Progress of Physics in the Nineteenth Century" remarks: "Just as the 19th century began with dynamics and closed with electricity, so the 20th century begins anew with dynamics to reach a goal, the magnitude of which the human mind can only await with awe."

March 8, 1910.

List of the Steps Which Led Reynolds to the Discovery of Gravitation.

1. On the Extent and Action of the Heating Surface of Steam Boilers. Pages 81-85, Vol. I. Papers on Mechanical and Physical Subjects. 1874-5.
2. On Certain Dimensional Properties of Matter in the Gaseous State. Pages 257-390. Vol. I., Papers on Mechanical and Physical Subjects. 1879.
3. On the Equations of Motion and the Boundary Conditions for Viscous Fluids. Pages 132-137. Vol. II., Papers on Mechanical and Physical Subjects. 1883.
4. Experiments showing Dilatancy, a Property of Granular Material, possibly conected with Gravitation. Pages 217-227, Vol. II., Papers on Mechanical and Physical Subjects. 1886.

   On the Dilatancy of Media Composed of Rigid Particles in Contact. With Experimental Illustrations. Pages 203-216. Vol. II., as above. 1885.
5. On the Dynamical Theory of Incompressible Viscous Fluids and the Determination of the Criterion. Pages 535-577, Vol. II. Papers on Mechanical and Physical Subjects. 1895.
   —*Cambridge University Press, London.*

Relation of Full Space to Empty Space in Different Pilings of Round Particles.

		Space of Volume.	Full Space.	Empty Space.
1.	Vertical Position	100	52.381	47.619
2.	First Triangular Position............	100	59.864	40.136
3.	Second " "	100	69.841	30.159
4.	Third " "	100	79.818	20.182
5.	Fixed Pyramidal "	100	72.877	27.123
6	Fixed Quadrilateral "	100	74.830	25.170

THE EVENING GROSBEAK IN MINNESOTA.*

A. O. U. No. 514. Hesperiphona vespertina vespertina (*W. Cooper*).

By Thomas S. Roberts, Minneapolis.

Minn. Ref. *Fringilla vespertina* William Cooper, Annals Lyc. N. H. N. Y., I, ii, 1825, 219-222 ("common about head of Lake Superior, at Fond du Lac, etc."; first record for locality later included in Minn.)—Wilson and Bonaparte, Am. Ornith., IV, 1831, 135 (common about head of Lake Superior, at Fond du Lac, etc.)—Nuttall, Man. Ornith. U. S. & Can., I, 1832, 526 (upper extremity Lake Superior).—Nuttall, Man. Ornith, U. S. & Can., II, 1834, 594 (borders of Lake Superior).—*Coccothraustes vespertina* Swainson and Richardson, Fauna Bor. Am., I, 1831, 269 (frequents the borders of Lake Superior).—Cooke, Rep. Bird Migr. Miss. Val., 1888, 178 (winter dates, notes, etc., southern Minn.)—Cantwell, O. & O., XV, 1830, 134 (common winter visitor).—Chamberlain, Nutt. Ornith., I, 1891, 367 (upper extremity of Lake Superior).—Hatch, Notes Bds. Minn., 1892, 291-293 (biog.)—McIlwraith, Bds. Ont., 1894, 291 (St. Cloud, St. Paul, Minneapolis, Red Wing).—Stone, Bds. East Penn. and N. J., 1894, 109 (eastward to Lake Superior, etc.)—Dart, Ool., XI, 1894, 84-86 (Litchfield).—Roberts, Wilcox Hist. Becker Co., 1907, 179. *Hesperiphona vespertina* Cooper and Suckley, Rep. Pac. R. R. Surv., XII., pt. ii, 1860, 196 (east to Lake Superior).—Baird, Cassin and Lawrence, Bds. N. Am., 1860, 409 (east to Lake Superior).—Hatch, Bull. Minn. Acad. Nat. Sci., 1874, 58 (winter visitant from November till early spring, etc.; first definite Minn. record).—Band, Brewer and Ridgway, Hist. N. Am. Bds., I., 1874, 450 ("east to Lake Superior')'.—Holder, Mus. Nat. Hist., III, 1877(?), cxliii (east to Lake Superior).—Tiffany, Am. Nat. XII, 1878, 471 (occurrence at Minneapolis, habits, etc., based on observations of Roberts, Herrick & Williams).—Roberts, Bull. Nutt. Ornith. Club, IV, 1879, 237-238 (late spring departure, dates Minneapolis).—Coues, Bull. Nutt. Ornith, Club, IV, 1879, 62, 71, 72 (synonymy, two references, Ames [should be Hatch] and Tiffany; latter also referred to in text).—[Allen], Bull. Nutt. Ornith. Club, VI, 1880, 51 (bib. ref. to article by Tiffany in Am. Nat.)—Roberts, Geol. Nat. Hist. Surv. Minn., 9th Ann. Rep., 1881, 379 (regular winter visitant, habits, dates, localities, etc.)—Hatch, Geol. Nat. Hist. Surv. Minn., 9th Ann. Rep., 1881, 364 (winter visitor).—Cooke, Auk. I, 1884, 244 (White Earth, Chippewa name).—Herrick, Bull. Sci. Lab. Dennison Univ., I, 1885, 5-15, 2 plates (biographical matter based on observations made in Minn. followed by a detailed description of the osteology of the species with brief reference to the myology; an indifferent colored plate of the female and a plate exhibiting chiefly osteological characters).—Selover, Sunny South Oologist, I, 1886, 33 (Lake City).—[Winchell], Geol. Nat. Hist. Surv. Minn., 14th Ann. Rep., 1886, 144, 148 154, 156 (Minneapolis and Pelican Rapids, twenty specimens, dates, etc.)—Sharpe, Cat. Bds. Brit. Museum, XII, 1888, 34 (range east to Lake Superior).—Cantwell, O. & O., XV, 1890, 90 (Lake Minnetonka, had not left

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* This article was prepared in its present form for a Report on the Birds of Minnesota in course of preparation by the Minn. Nat. Hist. Survey. It is here offered in full as it will probably have to be much condensed when used for the purpose intended. The annotated synonymy or "Minnesota References" arranged so as to give a chronoligical history of the species so far as Minnesota is concerned is in part the work of Dr. L. O. Dart, while the description of the species was prepared by Mrs. F. W. Commons from technical works on Ornithology, chiefly Ridgway's Bds. N. & M. A., aided by the study of a considerable series of skins in the collection of the Survey.

May 15, 1888).—Coues, Key N. Am. Bds., I, 1903, 377 (regularly to Lake Superior).—*Cocothraustes vespertina* [Hatch], Trans. Minn. State Hort. Soc., VII, 1879, 90 (arrive about first of November; plentiful on Nicollet Island).—[Anon.], Birds, II, 1897, 80 (upper Miss. Valley, Lake Superior).—Gibbs, Minn. Hort., XXXII, July, 1904, 255 (McCray's list; also in "Trees, Fruits and Flowers of Minn.", XXXII, July, 1904, 255).—*H. vespertina* Bailey, O. & O., IX, 1884, 62 (Elk River, regular winter visitor, notes on food).—Cooke, O. & O., IX, 1884, 65 (common in Minn. this spring, etc.)—*Coccothraustes vespertina vespertina* Mearns, Auk. VII, 1890, 246, 248, 249 (reference to seventy-two specimens taken at Fort Snelling, Minn.; part of series used in separating *C. v. montana*).—*Coccothraustes vespertinus* Apgar, Birds of U. S., 1898(?); 115 ("western British provinces east to Lake Superior," etc.)—Scott, Bird Studies, 1898, 163 (more regular than elsewhere (winter) in Minn., Wis., etc.)—*Hesperiphona vespertina vespertina* Ridgway, Bds. N. & M. Am., I, 1901, 40-41 (synonymy, four references: "Lake Superior in summer," Swains & Rich.; W. W. Cooke; Tiffany; Roberts)—*Evening Grosbeak* Roberts, F. & S., XIV, 1880, 328 (seen April 7).—Roberts, F. & S., 1880, 428 (May 3).—G. [leason], The Kingdom, X, 1898, 609 (winter visitant).—G. [leason], The Kingdom, X, 1898, 626 (occasionally in winter).—Gleason, The Kingdom, XI, 1899, 286 (photo; habits, food, etc.)

Sp. Char. *Adult male.*—Top of head, black; forehead and line over eye, yellow; a narrow black line separating the yellow of forehead from base of bill and extending down on either side to join a black area in front of each eye; rest of head with neck and upper back, plain olive changing gradually to clear lemon yellow on scapulars and rump; upper tail coverts and tail black; wings black with a conspicuous white patch formed by innermost greater coverts and secondaries which are pure white, the former sometimes edged with yellow and frequently in fall and winter specimens with more or less dull black on inner edges and tips; under parts shading from yellowish olive on chest to lemon yellow on abdomen and under tail coverts; longest feathers of under tail coverts sometimes partly white and rarely with a broad, transverse black band near the tips; leg feathers black, narrowly tipped below with yellow; bill varies from greenish horn color to light yellowish green; iris brown; legs and feet dusky flesh color. *Adult female.*—Top and sides of head dark gray, separated from the lighter gray of the back by a more or less distinct band of yellowish olive green; back more or less tinged with yellowish olive; rump paler gray or buffy, posterior feathers sometimes extensively black at the base; throat white or whitish with a more or less distinct dusky streak along each side; under parts light buffy gray, usually more or less tinged with yellow especially on sides of chest; abdomen paler gray; under tail coverts white; under wing coverts chiefly light yellow; wings dull black, with innermost greater coverts largely dull white, tertails largely light gray with white terminal margins and often more or less blotched with black; primaries more or less edged with white or pale gray, sometimes only obliquely tipped with this color; the three outermost quills white at the base, forming a distinct patch; secondaries more or less marked with white, the inner ones extensively so; upper tail coverts black with large terminal spots of pale grayish or white; tail black, with inner webs of feathers broadly white at the ends, these white markings most extensive on outer feathers, occasionally occupying the terminal one-third and sometimes including the outer webs of all the feathers showing white at tips. *Young.*—Similar to adult female, but colors duller and more brownish with markings less sharply defined; dusky streaks on sides of throat less distinct or wanting; under parts paler and more buffy with little if any gray; bill dull horn color or brownish. Length 7.50-8.25; extent 13.50-14.12; wing 4.25; tail 2.63-3.00; bill .75 long, .67 deep, .60 broad.

General Range.—"Central North America. Breeds in western Alberta; winters in the interior of North America south of the Saskatchewan and east of the Rocky Mountains, and south more or less irregularly to Missouri, Kentucky, and Ohio, and east irregularly to western Pennsylvania, New York, New England, and Quebec." (*A. O. U. Check-List.*) Represented in western North America by subspecies *montana*.

Minn. Range. Irregular visitant from the north into all parts of the State during fall, winter and spring—Sept. 28 to May 19. Most common in late winter and early spring.

Migration Dates.

Fall.

Kittson Co.: Oct. 4, '81 (several near Hallock), *Roberts;* Sept. 28 (one), Oct. 23 (one), Oct. 31 (nine), '95 (all at St. Vincent) *Peabody;* Itasca Co.: Oct. 6, '95 ("a flock of about a dozen," several taken) *Ogden;* St. Louis Co.: Nov. 16, 1900 (several at Ely) *Warren;* Ottertail Co.: Oct. 17 (Deer Lake), Oct. 27 (Lake Lida, "a flock of six"), '85, *Washburn;* Sherbourne Co.: Oct. 17, '84 (one male at Elk river), *Bailey;* Wright Co.: Oct. 27, '98 (two at Monticello) *Nutter;* Hennepin Co.: Dec. 19, '75 (first); Dec. 19, '76 (first); Oct. 28, '80 (two males and four females; first, all at Minneapolis), *Roberts;* Nov. 7, '84 ("about 50"), at Minneapolis, *Stebbins;* Fillmore Co., Lanesboro: Oct. 18, '85; Oct. 27, '89 (several); Nov. 1, '91 (one, the only one seen during the winter of 1891-2); Nov. 1, '96 ("several hundred feeding on fruit of hackberry; first of season" at Lanesboro), *Hvoslef.*

Spring.

Fillmore Co., Lanesboro: May 13, '84 (abundant, last seen); May 4, '86 (last, common all winter); Apr. 13, '87 (last, unusually abundant during winter of 1886-7); Apr. 2, '88 (small flock, not seen during winter); May 4, '89 (last, a flock); May 14, '90 (last); Apr. 11, '91 (last); Apr. 25, '97 (last) *Hvoslef;* Houston Co.: May 8-13 (various years at La Crescent) *Harrison;* Hennepin Co., Minneapolis: May 17, '76 (many; the last); May 6, '77 (a flock; the last); May 19, '79 (a flock; the last); Apr. 11, '80 (many) *Roberts;* Stearns Co.: May (three killed at Sauk Center; year not stated) *Barker.*

There is, perhaps, no bird that comes to Minnesota that is more singularly beautiful in the full perfection of its nuptial plumage, or that attracts more lively interest among all bird-lovers than the Evening Grosbeak. Fitful and uncertain in the manner of its appearance and coming unheralded, as it does, from the little known boreal region where it makes its summer home, there is ever a captivating mystery surrounding it, that adds a certain piquancy to its charm. Wild and secluded as its native haunts are known to be, the unexpected tameness and confiding nature which it displays while a visitor among the dwellings of men, but serve to make it the more an object of admiration. Its disappointing illusiveness, too, disappearing as is its wont just when a temperate-zone summer seems about to claim it for its own, arouses a speculative interest which commands the attention year after year. Lingering thus in the springtime until surrounded by all the fullness of verdure and many settled activities of late May and associated then on intimate terms with a varied throng of feathered comrades who are busily engaged with their domestic duties, it, suddenly, just as it seems certain that it has at last decided to take up its abode among these strangers, disappears from its long familiar haunts, between one day and the next, and vanishes no one knows exactly whither, or for how long a sojourn. A life time may be spent in close intimacy with birds and yet the clear whistle or a gleam of the unique tri-colored vestments of the Evening Grosbeak, never fails to secure a pause in one's occupation and a moment passed in admiration and wonderment. Until the remarkable and previously unnoted advent of thousands of these birds into the whole northeastern portion of the United States in the winter of 1889-90 the Evening Grosbeak, except in a few favored localities, was a veritable will-o'-the-wisp, a sort of disembodied bird-spirit to most ornithologists.

In the northern portions of Minnesota the Evening Grosbeak often makes its appearance early in the fall and as it frequently does not leave the southern part of the State until late in the spring it is evident that many individuals of the species do not linger long in their arctic nesting places after the duties directly incident to nidification are completed. The considerable array of dates given above will serve to show, in a definite manner, the times of arrival in the fall and departure in the spring for a number of years and at various localities throughout the State. The earliest date, it will be seen, is Sept. 28, 1895, when a single bird was seen by Peabody at St. Vincent in the Red River Valley close by the International Boundary Line. There are early October records for other localities in the northernmost counties and by the last of that month they may occasionally be found as far south as Minneapolis; but usually they are seen for the first time in the southern part of the State during November or early December. In the spring they frequently, if not generally, remain in the southern part of Minnesota until May and have been kept under daily observation at Minneapolis, latitude 45°, as late as the third week of that month (May 17, 1876; May 19, 1879) and at Lanesboro, Fillmore County, latitude 43° 45', Dr. Hvoslef has several times recorded the "last" during the first half of May—(May 13, '84; May 4, '86; May 4, '89; May 14, '90). They are sometimes more common during the spring months than during the winter, seeming to congregate in large flocks, in favored localities, before taking their departure for the north. Thus Dr. Hvoslef writes that after having been common at Lanesboro throughout the winter of 1883-4, the Evening Grosbeaks assembled in the valley of the Root River during April and early May in such great numbers that they were sometimes among the most abundant birds in the timber below the village, "making the spring woods resound with their noisy notes." Some years they are entirely absent or very rare or appear only in certain places for a short time wandering over the country in an erratic manner. Other winters they are abundant and are to be found almost everywhere in considerable flocks. During the first three months of the year 1890 there was a remarkable incursion of these birds into the northern United States.* They appeared in great numbers not only in their accustomed winter haunts, but in regions where they had not previously been known, as throughout almost all of New England. The winter was a comparatively mild one and it is probable that their southward movement was determined by a failure further north of the food supply upon which they depend rather than by climatic conditions.

From the time of their appearance in Minnesota in the fall until the spring months they are commonly seen in little companies of six or a dozen individuals. Single birds or pairs may now and then be encountered probably separated for a time from their companions. Their movements, the places where they assemble and the length of time they stay, are entirely dependent upon the food supply. They are especially fond of the keys or fruit of the box elder, sugar maple and ash and from this source they derive their chief sustenance during their stay in southern Minnesota. They are very adroit in neatly cutting transversely with their powerful beaks the dry covering of the juicy kernels and dexterously and quickly extracting the latter. The light wings of the keys go eddying to the ground below which is soon thickly strewn with these bits of refuse and gives plain indication of the feeding places of the Grosbeaks. The fruit of the box elder and ash they nimbly secure from the clusters hanging throughout the winter on the ends of the branches but the keys of the sugar maple, shed the previous season, they pick up from the ground usually after the snow has melted in the spring. They eat also the seeds of the berries of the hack-berry, high bush-cranberry, mountain ash, juniper, cedar and probably also when hard pressed the seeds of any edible berry or fruit that offers. The skins and pulp they always reject, even splitting open crab apples to get at the seeds within. They generally locate wherever they find an abundant supply of this sort of food and remain in the vicinity until it is exhausted or they are called away by the migratory instinct. As spring comes on they are apt to assemble in sugar maple groves and pass their time partly on the ground picking up and shelling out the sprouting keys and partly in the branches above piping in unison their spring notes. Frequent mention is made by writers of this grosbeak eating the buds of various trees, but after close observation and the examination of many stomachs I am confident that it is very rarely, if at all, that this practice is indulged in. I have seen them apparently feeding among the buds of trees and in spring among the catkins of various trees, but examination showed that they had not eaten either. When thus engaged they may be in search of insect food in some form.

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* Brewster in Appendix to Minot's Land-Birds and Game-Birds of New England, second edition, 1895, 470-471; Butler, Auk, IX, 1892, 238-247.

In years gone by there was usually in the spring time a goodly assemblage of Evening Grosbeaks in the sugar maple grove on upper Nicollet Island between east and west Minneapolis, where it was an easy matter to keep in daily touch with them and here many of the observations forming the basis of this article were made by the writer and his father. They still resort occasionally to this ancient trysting place in spite of the encroachments of a big and noisy city. The commonly observed fact that this bird is found so frequently about the streets and yards of cities and towns is probably not due to any particular desire for the company of man, but rather to the circumstance that box elder and hackberry trees have been planted so universally of late years as shade trees, that a supply of food is there offered of which their fearless and unsuspicious nature enables them to unhesitatingly avail themselves. So tame are they that they feed without the least fear about the very doorsteps and porches of dwellings and will remain unconcernedly among the lower branches of small trees when approached within a few feet. Indeed they may even be encouraged in the wild state to feed from the hand or alight upon the person as entertainingly narrated by Mr. Wm. Rogers Lord in an illustrated article in Bird Lore for January-February, 1902, and when captured become quickly reconciled to confinement and make very docile and entertaining pets.[*]

The Evening Grosbeak has, while with us at least, nothing that may be dignified by the name of song. Butler in his Birds of Indiana states that towards spring they have a "rambling, jerky warble, beginning low, suddenly increasing in power, and as suddenly ceasing, as though the singer were out of breath;" but in a long experience I have never heard any such song nor can I find any other reference to it so conclude it must be of very infrequent occurrence.[*]

Its usual utterance is an unmistakable, loud and forcible whistle or pipe, sometimes rather shrill and rasping, at other times almost bell-like in quality. It is possessed by both male and female alike and is heard as the birds call to one another from their various stations in the tree-tops or as they pass overhead in their erratic and undulatory but rapid flight. They have also a weak, short, "beaded" note or scream, somewhat resembling that of the Waxwing, most commonly heard while the birds are feeding in a flock or sitting quietly about among the branches of a tree. As spring advances all these notes assume a softer or more mellow character and when a score or more of the now richly vested Grosbeaks assemble in some leafy treetop and give vent in unison to their joyous feelings there results an unbroken medley of whistles and trills unique in bird-music. Satisfied as the birds appear with their effort there is no particular melody about the performance which can be compared quite accurately with the chorus produced by a lot of frogs piping in a woodland marsh of a summer evening. While feeding the birds are either silent or utter the above notes in a quiet, subdued undertone.

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[*] Shufeldt, Notes upon Coccothraustes vespertina as a Cage bird, Auk, VII, 1890, 93-95; Butler, Auk. X, 1893, 156-157.

[*] Since writing the above I have come upon the following by C. L. Herrick in his article on the Evening Grosbeak in the Bull. of the Scientific Laboratories of Dennison University, Granville, Ohio, 1885: "In spring, upon the approach of the breeding season, the males cultivate the muses in an odd but not displeasing little song. This song consists of several successive repetitions of a short warble, followed by a similar strain closing with a shrill cry, like the finale of a black-bird's song. The phrase which makes up the body of the song is musical, but is so abruptly terminated (as though from lack of breath or of ability,) that it is annoying when heard singly, for one is subjected to much the same nervous expectancy felt in listening to a hen's cackle when quite leisurely "working up the agony" sufficiently to sound the final note. A flock of a dozen or more singing together produce a very musical effect."

The nest and eggs of the eastern form of the Evening Grosbeak are still little known and indeed the exact region to which it retreats in the nesting season is not clearly defined.[*] It is probably somewhere in the vast boreal regions to the west of Hudson Bay. Several nests of the western subspecies (*Hesperiphona vespertina montana*) which breeds at high altitudes in the Cascade, Sierra Nevada and Rocky Mountains as far south as Arizona and New Mexico have been found and as they would in all probability be indistinguishable from those of the eastern form, a brief description of them will serve to indicate the manner of nidification of the species as a whole. The first published account was of a nest found by Mr. E. H. Fiske in Yolo county, California, and described by Mr. Walter E. Bryant in a paper before the California Academy of Science on June 20, 1887. "The nest, containing four eggs, was taken May 10, 1886, but incubation was so far advanced that he was unable to preserve them. In general shape, color and markings, they were similar to eggs of the Black-headed Grosbeak, but in size he thinks they were somewhat larger."

"The nest was built in a small live oak, at a height of ten feet, and was a more pretentious structure than is usually built by the Black-headed Grosbeak, being composed of small twigs supporting a thin layer of fibrous bark, and a lining of horse hair."[*] On June 5, 1884, Mr. John Swinburne of Springerville, Arizona, found a nest of the Evening Grosbeak in a thickly wooded canyon some fifteen miles west of that town. "The nest was a comparatively slight structure, rather flat in shape, composed of small sticks and roots, lined with finer portions of the latter. The eggs, three in number, were of a clear, greenish ground color, blotched with pale brown. They were fresh. The nest was placed about fifteen feet from the ground in the extreme top of a thick willow bush." This was at an altitude of 7,000 feet. This was probably the first nest of this species ever found by an ornithologist but it was not reported until after the California nest.[*] Others have since been found and Mrs. Florence Merriam Bailey sums up the information to date in the general statement: "Nest.—15 to 50 feet from the ground in the top of a conifer or thick willow, a comparatively flat, slight structure of small sticks, roots, and sometimes tree lichens lined with finer roots. Eggs.—3 or 4, clear green, blotched with pale brown."†

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[*] In the Auk, Vol. XXVI, Oct. 1909, pp. 390-400, is an article by Sidney S. S. Stansell entitled "Birds of Central Alberta," in which is the following note in regard to the Evening Grosbeak: "Quite rare, I located a nest in June, 1908, which contained a dead full-fledged young male. The nest was up 40 feet in a white birch tree."

[*] Bull. Cal. Acad. Sci., II, 1887; J. P. Norris, O. & O., XII, No 9, Sept. '87, 144.

[*] Auk. V, Jan., 1888, 113-114.

As the Evening Grosbeak possesses such a fascination for nearly all bird students it will no doubt be of historical interest to many to peruse the rather curious notes which accompanied the original description of the species, more especially as they are not readily accessible to the general reader. William Cooper first described the Evening Grosbeak in a communication read before the Lyceum of Natural History of New York City, January 10, 1825, and published in the Annals of that Society for the same year, Vol. I, part the second, pages 219-222. After a technical description of a male in full plumage the following account is given: "The specimen from which the description is taken, was sent to the Lyceum from Sault Ste Marie, near Lake Superior by Mr. H. R. Schoolcraft, and is labeled Paushkundamo, the name given it by the Chippewa Indians. Mr. Schoolcraft has since favored me with the following account. It is a little singular that the meaning of the Chippewa name should so nearly coincide with that of the subgenus in the language of the system."

"'Paushkundamo.' This word is derived from the Chippewa verb paushka-un, to break. The termination indicates the object acted on, and is in accordance with one of the rules of their language, which permits the formation of compound words from a verb and substantive, dropping one or more syllables of each for the sake of euphony. The word paushkaun is the animate form of the verb, and is used only in particular reference to soft, fleshy or vegetable substances, as a fly, a berry, etc. The word will therefore admit of being rendered fly-breaker, berry-breaker, etc.

"This bird appeared about Sault Ste Marie, M. T., during the first week in April, 1823. The individual under examination was shot on the 7th of April, in the Evening. An Indian boy was attracted into the woods by its peculiar, and to him strange note. There were a few birds in company: they were seen for a short time about the place; but none have since appeared. The species is said to be common about the head of Lake Superior, at Fond du Lac, etc."

"Major Delafield, in the execution of his duties as agent of the United States for boundaries, met with the same bird in the month of August, 1823, near the Savannah River, northwest from Lake Superior, and has obligingly communicated th following extract from his notes at the time:"

"'At twilight, this bird which I had before heard to cry in a singular strain, and only at this hour, made its appearance close by my tent, and a flock of about half a dozen perched on the bushes in my encampment. They approached so near, and were so fearless, that my canoe-men attempted to catch them, but in vain. I recognized

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† Handbook Birds Western U. S. 1902, 307.

this bird as similar to one in possession of Mr. Schoolcraft, at the Sault Ste Marie.'"

"'Its mournful cry about the hour of my encamping, (which was at sunset) had before attracted my attention, but I could never get sight of the bird but on this occasion. There is an extensive plain and swamp through which flows the Savannah River, covered with a thick growth of sapin trees. My inference was then, and is now, that this bird dwells in such dark retreats and leaves them at the approach of night.'"

The latter part of this account, though presenting as it does, a mistaken impression, evidently furnished the suggestion for both the scientific and common names of this bird. That it is an evening singer or is in any special way associated with the decline of the day is erroneous and the name by which it is now universally known is without any particular significance.

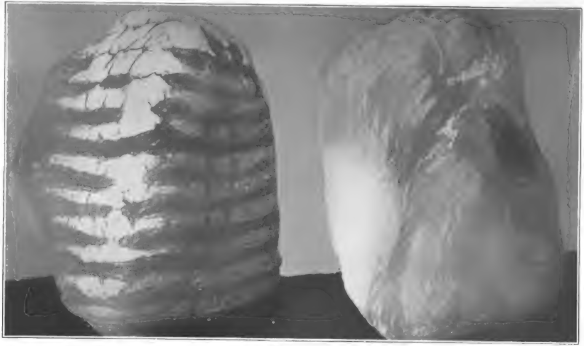
EXTINCT PLEISTOCENE MAMMALS OF MINNESOTA.

N. H. Winchell.

PLATES X. AND XI.

[Read May, 1909.]

There was an epoch of geological history,—how long in years or centuries we do not know, but it must have been long—which preceded the Glacial epoch, or epochs, and which followed after the Tertiary, which is commonly called Pleistocene. During the Pleistocene the climate of Minnesota was approximately the same as the present, and the country was clothed more or less with a flora similar to that of the present. The general configuration of the surface, however, was rough. There were deep-cut gorges, in the bottom of which flowed the streams. The uplands were diversified with projecting rock cliffs, about whose bases was accumulated the waste of many centuries. The only boulders that could be found were such of the fallen cliff-masses as had not yet decayed. The soils were light and fine, resulting from the disintegration of the rocks. They were sandy, or in some places clayey, depending on the conditions of drainage. There were extended tablelands, sometimes rising bench after bench one above the other. In the Archean areas there were peaks of granite and of gneiss that rose more irregularly above the general surface. Amongst these granitic knobs and along the bases of the terraced tablelands, the streams meandered with about the same crookedness as those of to-day, but with greater agreement with the boundary lines separating the different formations. They followed prevailingly the erosible outcropping edges of the softer formations, and when they passed from one formation to another they were likely to form local lakelets, or cascades, or larger waterfalls, and these waterfalls receded up their



Elephant's Tooth, from the gravel terrace of the Mississippi at Wabasha valleys amenable to the same forces of erosion as those of the present day, until the streams finally reached the stage of senescence, and the waters descended quietly without waterfalls, like the base-leveled streams of southern latitudes at the present time.

With such a climate, and with such adaptable and attractive physical conditions, nothing was wanting for the existence of a fauna of the most diversified types. Indeed we know that the present fauna has its ancestry in the Pleistocene. The Glacial epoch simply caused the migration of the Pleistocene animals southward, and on the recession of the ice-border allowed the same fauna to return to re-occupy the renovated lands. It is needless to dwell on the change produced in the local physiography by the ice age. Suffice it to say that on the retirement of the ice ,the present conditions, approximately, were inaugurated. The river gorges were filled, the streams turned from their courses, the granitic crags were thrown down and buried and the whole country rendered more smooth.

But the fauna had suffered somewhat by the glacial cataclysm. Some of its largest species had become extinct, and some had become so dwindled in number, or so reduced in vigor, that their post-Glacial representatives are sometimes not recognized as the same species, although probably genetically the same as the Pleistocene. Of these extinct large mammals I wish to call your attention to a few whose remains have been found in Minnesota. Some of these survived the Glacial period, and returned to Minnesota and flourished during the inter-Glacial and post-Glacial epochs. If we consider these remains in the order in which they have been discovered they will appear about as follows:

1. *Eliphas primigenius*, the mammoth.

It is well known that in Siberia and Alaska the remains of the mammoth are common. It is but recent that an entire animal was found incased in ice and the flesh preserved. This specimen was photographed in its place and afterwards it was remounted in the museum at St. Petersburgh in the attitude in which it had when found. The remains of the elephant, which was without much doubt only a southern species (or several species) of the mammoth of the north, have been found over a wide extent of latitude in North America, extending as far south as Mexico.

The geologic and geographic relations of the elephant with the Glacial drift, and his chronologic relations with man, have been the subject of considerable investigation. There is abundant evidence that the elephant inhabited Minnesota in late Pleistocene time. His skeleton and especially his teeth, have been discovered in several places. In general throughout the central part of the United States the remains of the elephant and of the mastodon appear to have about the same age, and it is certain that they both survived the vicissitudes of the Glacial epoch by migrating toward the south where they found more genial climate.

In the case of the discovery of a tusk only, it is usually impossible to distinguish between the elephant and the mastodon, since they both carried enormous tusks of ivory. But their teeth were quite different. Both tusks and teeth were found at Stockton, in Winona county prior to 1885 and were brought to the attention of the Geological Survey by Prof. John Holzinger. All the facts of this discovery are published in the tenth annual report of the survey and the conclusion seems to be warranted that these remains represent the great mammoth of the north. They were embedded in the loess of that locality, which is now referred to the Iowan stage of glaciation. In the loess at points in Iowa similar elephantine remains have been exhumed, sometimes accompanied by flint arrowheads and other human relics.

The remains of what was presumed to be a mastodon were found near Northfield in the excavation of a gravel bank in 1879. But, as the specimen consisted of only a part of a tusk it may have belonged instead to an elephant. This discovery is mentioned in the final report of the Geological Survey, vol. 2, p. 670.

A similar statement concerning the finding of mastodon remains in Winona county, at Minnesota City, is to be found in vol. 1, of the final report, p. 264; and further, in vol. 2, p. 397, at Stillwater in Washington county. These may also have been elephant tusks, since in neither case was the identification reliable in the absence of the characteristic teeth. It is to be noted that in both these cases the remains were imbedded in terrace gravel pertaining to the flooded-river stage of the Wisconsin epoch, and hence probably much later in date than the elephant remains found in the loess at Stockton in Winona county.

According to Mr. E. E. Woodworth a large elephant's tooth and a large bone from the skeleton were found some years ago in a marsh near Fair Haven, Stearns county. These were very hard and black, and the tooth particularly had a hard shining surface.

Some years ago a large elephant's tooth was found in Nobles county, in the southwest corner of the state. According to Mr. T. B. Walker who procured it and presented it to the Museum of the Minnesota Academy of Science, where it is still preserved in good condition, it was found in gravel at about twenty-seven feet below the natural surface.

Judge Crosby, of Hastings, recently presented to the Historical Society, at St. Paul, a large fragment of (apparently) the top of the femur of an elephant, which was found in gravel in the terrace of the Mississippi.

Mrs. Harriet C. Amberson, of Minnesota, also lately presented to the University museum similar large fragments of the skeleton exhumed in Minneapolis about fifteen years ago at the site of the carshops of the Minneapolis & St. Louis railroad.

The writer was in Europe at the time of this important find, and the specimens were scattered, and largely lost sight of. According to the Minneapolis *Times* a cylindrical tusk was found that measured nine feet in length and eight or nine inches in diameter, and bones of all sizes and shapes were so numerous as to prove the former presence of an entire animal. A single tooth was found but was ruthlessly crushed by the workmen, its fragments indicating, according to the description, that it was elephantine. Mr. S. C. Amberson, foreman, made an attempt to get all the pieces together. After his death Mrs. Amberson preserved the large fragment of the femur, which she lately presented to the University Museum.

According to statements made in the Minneapolis *Journal* Nov. 19, 1908, a number of mammoth bones were found at lake Minnetonka by workmen in dredging in thirty feet of water off Huntington's point, near Arcola, about 100 feet from the shore. These remains embraced a hip bone, eight vertebræ and a leg bone. I have not been able to see these bones.

In 1891 Prof. A. F. Bechdolt, of Mankato stated that he found a "tooth of a mastodon," with a fragment of the lower jaw, in a ditch being dug by the city in one of the streets of Mankato.

Capt. Jos. Buisson stated that a mammoth tooth was found opposite Lake City, near Stockholm, on the shore of lake Pepin.

Toward the northwest, in North Dakota, Dr. Upham has given the particulars of the finding of elephant's (or mammoth's) remains at an excavation through the Herman beach near Ripon in Cass county. This is published in his memoir on Lake Agassiz for the United States Geological Survey, p. 322. In this case several teeth and vertebræ, as well as tusks, were found. These lay below the gravel of the beach and about a foot below the upper surface of the Wisconsin till sheet. These fossils must be considered as of about the same date, as the teeth taken from the river gravels further south, though probably somewhat later.

About two years ago a small elephant's tooth was found at Wabasha, in the gravel terrace of the Mississippi river, and I gave a description of the circumstances and of the nature of this tooth in a paper read before this Academy in May, 1907. It was brought to me by Mr. John D. Stritch, but was found by his brother George P. Stritch who was superintendent for the railroad in the excavation of the terrace for ballast and grading. By the steam shovel it was thrown on the car with the gravel, was transported to Greathorn spring, which is between Dresbach and River Junction, in Winona county, where, in unloading the car by steam plow, it was scraped off the car with the gravel, and was first observed on the dump by Mr. Stritch.* It is illustrated by plate X.

This tooth contains ten double plates of hard enamel folded close so as to make double transverse ridges, the dentine in each plate being quite scant. The width of the intervening layers of cementum is but slightly more than that of the plates. The greatest width of the tooth is three inches and its greatest length, on the grinding surface is 4½ inches.

The interesting feature exhibited by this tooth is its gravel-worn exterior, showing that it was for a time subjected to the rolling and wearing action incident to the transportation and deposition of the gravel and stones of the terrace, and hence that it dates from the time of the formation of the terrace, which was the Wisconsin epoch. The cementum which on one side, and at one end, spreads outward from between the plates and covers by a continuous layer the whole side of the tooth, is worn off on the other side. That side of the tooth which is the opposite to the grinding surface is worn away so that it presents a smoothly rounded yet bluntly wedge-shaped edge, the enamel and the dentine being cut by the gravel-worn surface uniformly, and together showing a polished rounded form resembling that of numerous boulders and stones that were subjected to the wear and tear of the tumultuous and driftladen waters. The enamel of the plates expands and becomes a continuous mass, with no dentine nor cementum, and this fact seems to have given the tooth greater firmness and endurance in the root portion than in the crown. If, within the jaw, the tooth had any connection with a porous bony tissue, or terminated at the roots by any processes or vanishing plates of enamel, it shows no trace of such articulation. The view on the left of the photograph* shows the grinding surface and one side almost entirely denuded of cementum which on the other side is so nearly intact as to wholly cover the enamel plates. The view at the right shows the rounded condition of one end of the tooth, together with a portion of that side which is still covered by the spreading cementum. It also shows the rounded form of the root where the enamel and the cementum are equally worn down to a smooth surface.

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*At present this tooth is owned by Mr. O. O. Whited of Minneapolis.

This list of elephant remains of Minnesota is probably far from complete.

There is evidence therefore, within Minnesota, that the mammoth was a denizen here from the time of the loess of the Iowan epoch, that he continued through the fourth inter-glacial stage, the Peorian, survived the intensity of the Wisconsin ice epoch (which was the last) and lived on the surface of the Wisconsin till sheet long afterwards; and, considering his late extinction in Siberia, it is reasonable to infer that the ancestors of the American Indian were familiar with his enormous bulk, and slew him with their stone-headed arrows.

As to the Mastodon, it is very probable while no remains have been sufficiently demonstrated within the limits of Minnesota, and those of the Mammoth are well verified, and we cannot safely therefore affirm that the Mastodon ever inhabited the state, yet that he did, and that his remains are liable to be discovered. Judging from the comparative numbers of the mastodon and the elephant found at the celebrated Big Bone lick in Kentucky, it seems that the range of the mastodon was more southerly than that of the mammoth. Of the teeth found at that celebrated locality, the relative numbers were such that the mastodon were five to one of the mammoth.

2. *Castoroides ohioensis.* Next in order of discovery, was the great extinct Ohio beaver, whose size was about that of the present black bear. This discovery was made at Minneapolis, at the corner of Washington avenue and Fifteenth avenue north in 1879, in the process of digging for a cistern. There is a full description of this dis-

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* Plate X.

covery in the eighth annual report of the Geological Survey of the state, and from it are taken the following facts:

> The specimen was eight feet below the surface, under the sandy loam that lies on the brick clay, and about 20 feet above the level of the river, near the bottom of the sand and gravel. It was accompanied by some Unio shells. Its relation to the gravel, and to the topography of the valley, indicates that the animal inhabited the region when the border of the ice-sheet had already retired to the northward of Minneapolis, but that the river was maintained at a maximum flood stage by the dissolution of the ice fields that lay further north, and probably covered the northern part of the state. That is, it was cotemporary with the closing stages of the Wisconsin epoch. The specimen found at Minneapolis is preserved in the museum of the University. It consists of the left ramus and the lower left incisor. Its size indicates an animal somewhat larger than the specimen first found in Ohio and described by Foster, and also larger than that found in New York. It is however a little smaller than that described by Wyman from Memphis, Tennessee. The whole length of the specimen, when the parts are united, is 9½ inches, of which 5¼ inches consist of the projecting, uncovered incisor, a portion of the jaw having been broken away on the under side. The jaw contains four molars, perfectly preserved. Their outer surfaces are finely striated perpendicularly, and crossed transversely by undulations of growth, while the great incisor is externally grooved longitudinally with eighteen or twenty grooves, which are about twice as wide as the ridges that separate them. The four molar teeth have a structure like that of elephant's teeth, i. e., they are composed of transverse hollow lamellæ of enamel, embedded in a cementum, which also seems to fill, at least originally, the interior of the lamellæ.

According to Prof. A. J. Allen the Castoroides cannot be put into the same family as the modern beaver, but has affinities that ally it with the chinchilla, the vescacha, as well as the muskrat. The entire skeleton has never yet been found. It ranged over the whole United States, from South Carolina to New York and to Mississippi, and from Texas to Minnesota. L L

3. *Ovibos cavifrons.* In 1903 the skull of the musk ox was found by Mr. J. W. Franzen, now curator of our museum, where he has kindly placed the specimen. This discovery was made on the farm of Mr. McCracken, between Wabasha and Theilman, near the railroad from Wabasha to Zumbrota. The specimen was about ten feet below the surface, in a gravel terrace, of the valley. By Mr. Franzen I have been furnished with the accompanying photograph of this specimen. It consists of a skull, but without any teeth. The broad horn cores are conspicuous, but they do not embrace any of the curving horn terminations. The whole specimen is considerably worn and reduced so as to have lost most of its projecting angularities.

It belonged to a small animal, probably not mature: width transverse 5½ in., extreme width, including the horn cores, 8½ inches, length, front to rear 8¼ inches.

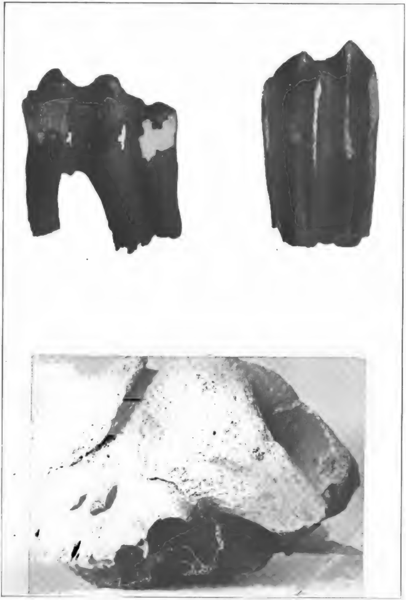
The region in which this specimen was found is within the "driftless area" of the state, as usually limited, but it is not as yet known how much drift pertaining to some of the older epochs of the Glacial period may still exist below the veneer of loam with which the region is covered. There is a conspicuous terrace formation extending along the Mississippi valley, which also ascends the tributary valleys, meeting with a series of terraces which were of the same date but which were formed from material derived from the west, brought down the valleys by the rivers whose sources were within the glaciated area. These conspicuous terraces are of the age of the Wisconsin epoch, and doubtless contain materials derived for the most part from the Wisconsin ice, but also embrace the wastage of the Iowan loess, which forms a surface mantle over the region. Indeed the Iowan loess must have suffered greatly from the action of the flooded streams of the Wisconsin epoch. From present knowledge it is impossible to affirm whether this skull dates from the Iowan loess epoch or from the terrace epoch of the Wisconsin, although it seems to have been found in a Wisconsin epoch terrace.

The interesting and important fact however is this,—that the musk ox occupied the region during either the loess epoch of the Iowan ice age, or the closing stage of the Wisconsin ice age. In either case it implies that the climate was considerably colder than the present climate,—a conclusion which is indicated also by the existence of what we know only as an arctic animal in temperate latitudes. It may be inferred that the Mississippi and its tributary gorges were a favorite habitat for arctic species.

The extinct musk-ox species, O. cavifrons, is regarded as specifically different from the living musk-ox, O. moschatus, although the latter is also regarded as the genetic descendant of the former. Like the mammoth and the reindeer the musk-ox retreated southward as the country became enveloped in ice on the approach of the Glacial epoch, or successive epochs, so as to destroy his feeding grounds, and on its retirement, probably in company with the Eskimo, followed the ice border again to the arctic region.

The remains of the musk-ox have been found at several places further south, viz., in Iowa, Missouri, Arkansas, Oklahoma, Kentucky, Ohio and West Virginia. These localities are all too far south to suppose that the Wisconsin ice sheet was the prime cause of the migration that brought the musk-ox into that latitude, but they might be due to the incursion southward of the earlier Iowan ice-sheet. This leads us to refer the Minnesota specimen to the loess of the region rather than to the terrace gravel of the Wisconsin.

4. ***Bison*** ***(latifrons?)*** About a year ago I was shown a couple of large fossil teeth by Mr. Edstrom, a student at the University, who had procured them from the discoverer. They were found near Mora, in Kanabec county, in Minnesota, in excavating for a drainage ditch. They were below several feet of tenacious clay, and were embraced in it. They are stained a dark brown, almost black, as teeth thus buried are frequently known to be. They were associated with several other teeth, and bones, probably belonging to the same animal, but the rest were scattered and lost. In the determination of the species to which these teeth belong I have been aided by Prof. S. W.



Teeth of Bison, near Mora.
Skull of Musk Ox.

Williston of Chicago University, and by Prof. W. J. Sinclair of Princeton University, and they concur in the following statement by Prof. Sinclair: (See plate XI.)

"They are the lower molars (2nd right and 3rd left) of two individuals of a large species of Bison, differing in several respects from a specimen of the recent species in our collection. I do not think that it is possible to be certain about the species. Your specimens are quite different from either Cervalces, the wapiti, or the moose."

These two teeth are quite different from each other. One is not worn at the crown, and appears to have been immature. It is 2½ inches long and 1⅝ inches wide. The outer incasing enamel embraces a roughly plano-convex cylindrical area which is loosely occupied at the root by two curved enamel lamellæ which are hollow, and which give the exterior of the tooth the appearance of being double, as they cause the body of the tooth to be divided into two main longitudinal parts. The outer side of the tooth has five prominent ridges of enamel separated by four furrows, all caused by undulating folds of the enamel. The inner side of the tooth shows simply the two main, rounded, vertical body-portions. Below the gum is a parasitic, simply tubular tooth, adherent between the two body portions in the outer angle formed by them. The roots are open below.

The other tooth is not so long vertically but is wider, and has been much worn away on the grinding surface. Its width is 1⅞ inches and its vertical length is two inches. This tooth is divided into three body-parts, but two only have internal lamellæ of enamel. The roots are closed at the bottom.

The only extinct Bison of America, so far as I can learn, is B. latifrons, and to that species these specimens may be provisionally referred until the discovery of more material may correct or confirm it. That was found in the Pleistocene of Texas, and has been supposed to be the progenitor of the present Bison.

These four species are only a part of the fauna of large animals that flourished in the United States in Pleistocene time. Their companions embraced extinct species of reindeer, elk, horse, lion, bear, sloth as well as the mastodon, and this fauna was spread apparently over the whole country, though not perhaps contemporary. Great and remarkable as this fauna appears, in contrast with the present, it was but the dwindling remnant of the Tertiary fauna which preceded it. From the Tertiary to the Pleistocene there was a reduction not only in the number of genera but also in the average size and number of individuals, and a similar change has continued to the present time. What may have been the cause of this extinction of the great mammals is unknown At the present time the agency of man is paramount, but we can hardly appeal alone to that cause in the Tertiary and the Pleistocene, in the dearth of evidence that man flourished cotemporary with these great mammals. The natural and inevitable effect of the Glacial period was certainly to confine some of the great mammals to restricted quarters and to reduced food supply. They probably also combatted each other, the young especially suffering from the attacks of cotemporary carnivores. To the Glacial period is due, probably, the practical extermination of this remarkable mammalian phase of animal life.

Whatever may be the cause, it is evident that the present exhibits but a depauperate state of the past, so far as concerns the physical and animal part of animate creation. The large, bizarre, and powerful types of life have given place to smaller and quicker-moving types. If rank, in the animal kingdom, were to be determined by the bulk of the animal, we would be justified in concluding that there had been a retrogressive evolution. But, while the body has become smaller, speaking of the average of mammalian life, there is reason to believe that there has been an increase of average cephalic power, particularly so far as regards man. The dominance of mind over matter has become more pronounced. The real progress of evolution therefore has not been retrograde, but ascensional. In place of brute force, there has appeared a greater sway of psychic force.

While therefore, from a physical standpoint, we may agree with Wallace, that we occupy a stage in the history of the earth's animal evolution, from which the largest and highest forms have just disappeared, we can affirm, it seems to me with equal assurance, that we have entered upon a stage in animal development which is higher in rank than any stage that has preceded the present, in proportion as the predominance of mind is higher than the predominance of selfish brute force.

THE DEVELOPMENT OF THE MINNEAPOLIS SEWER SYSTEM.

By Andrew Rinker, City Engineer.

The first sewer of the city of Minneapolis was begun June 15, 1871, 17 years after the founding and naming of the city. As I happened to come to Minneapolis that day I saw the first brick laid in the first sewer.

As I was soon afterwards connected with the city engineering department and was appointed City Engineer in April, 1877, and have continued in that position ever since, with the exception of the years 1892 to 1902, when I was in Montana, the sewer system has largely grown under my direction and supervision. But I desire here to acknowledge the faithful, able, and efficient work of my special Sewer Engineers, Mr. W. D. VanDuzee from 1870 to 1894 and Mr. Carl Ilstrup, from 1894 to the present time, to each of whom has been built a lasting monument of the best fame in these foundation civic improvements of a modern city.

From a topographical survey of the original town of Minneapolis the natural watershed into the Mississippi river was determined on for sewer drainage on the gravity system. This gravity system has been adhered to with an average flow of 2¾ miles per hour, there being as yet no pumping of our sewage. The division of the city's surface into separate trunk systems discharging into the river has developed on the basis of the natural topographical divisions of the city, modified, of course, by the irregular growth and varying necessities of the districts of a western city.

The first sewer was built on Wash. Av., from 8th Av. S. to Hennepin; was 44" in size, and designed to drain ultimately from 300 to 400 acres. Using the experience of Milwaukee and Chicago their formulas were adopted for determining the size of the sewers to the acreage drained. But the maximum of 1 inch of rain per hour as the basis of this formula was found by experience not to be sufficient for this locality where the average rain fall for 47 years has varied from a minimum of 16 inches to a maximum of 39 inches, and where a sharp shower will precipitate at the rate of over 2½ inches per hour. So the Adam's formula was adopted, allowing for 1½ to 2 inches of rainfall per hour.

The region drained by this first system, as the sewer extentions draining into this 8th Av. outlet were gradually built, in roughly bounded by 8th Av. S. to 3d Av. N and back to 7th St., with a loop taking in Western Av. to the railway and Hawthorn out to Lyndale. Only two and a half miles of trunk and collateral sewers were built in this first district during the first 11 years, i. e., to 1882.

By 1882 the growth of the city demanded the beginning of a second sewer system and a 6 foot brick sewer was started from the river at the foot of 11th Av. S. and going up that avenue, it was designed to drain the district bounded roughly by 9th and 13th Avs. S out to 8th St., thence west to include Nicollet and south to include Franklin. Similarly in 1882 was begun the third system by starting another 6 foot brick sewer coming up 4th St. S. from the river and turning up 15th Av. S. This system was to drain the district bounded by the river, 14th Av. S, and Franklin, with a loop between Bloomington and Chicago Avs. out to 25th St.

In connection with the third section of this 11th Av. S. system, the blocks from 15th St. to Franklin, occured the important change from construction by contract to construction by the city by day labor. This change was occasioned by the contract bids for this sewer being $40,000 above the City Engineer's estimate. So the City Council provided $5000. for tools and the work was done under our department within the estimate and with a few thousand dollars to spare. The first sewer had been built by contract by Spink & Nichols; and the 25 miles constructed by contract up to the end of 1885 were built by E. T. Sykes & Co., J. J. Palmer; Trainer, Forestall & Brandt; J. Gleason & Co., Tobin & Fallon, Thos Daley, Andrew Dolan, J. Burnes, J. H. Nevins, and R. M. Riner. But beginning with 1886 all sewer work has been done by the City Engineer's Department. This has been found a better plan in that it insures more thorough workmanship,—for sewers must be built for permanance rather than cheapness,—and it is not more expensive than contract construction when the costly extras of contract work are eliminated, as they are by the city work.

The beginning of the sewer systems of the East Side of the City were also made in this epoch-making sewer year of 1882. A small 15 inch sewer was begun on Central Av. to drain the area bounded 4th Av. S. E. to 2d Av. N. E. and back to Division St. The outlet of this Central Av. sewer was later changed from a direct discharge into the river to emptying into the mill race of the Pillsbury A Mill at 4th Av. S. E. Another East Side system was likewise begun in this same year from the foot of 10th Av. S. E. and running up that avenue to drain the district bounded by 5th to 16th Avs. S. E. and back to Spring St. Thus in 1882 3½ miles of new sewers were constructed, including the large trunk sewers for the new 11th Av. S. 4th St. S., Central Av., and 10th Av. S. E. systems, comparatively making a large amount of work as against the total 2½ miles up to that date from the beginning in 1871.

For the next 6 years the sewer construction was the extension of the branches of the systems already enumerated. But as yet only the central, south and southeast quarters of the city had been provided with trunk sewers. Some plan had to be begun for North and Northeast Minneapolis.

As the city supply of water was then pumped from the two pumping stations at the falls and on Hennepin Island it was not safe to empty sewerage into the river above the falls. This situation, together with the low elevation of the Bassett's Creek valley in North Minneapolis, determined the plan of starting a tunnel from the foot of 8th Av. S., below the falls, going up to 2nd St. thence diagonally to 6th Av. below Wash., up 6th Av. S. to 4th St., up 4th St. from 6th Av. S. to Hennepin Av. and thence diagonally to 5th St. and 4th Av. N. This tunnel, begun in 1889, was 8' in size, thru the sand rock beneath the limestone ledge, averaging 81 ft. beneath the street surface. Up 4th St. it followed a seam in the rock from which much water came into the tunnel. But by inserting in the masonry over 1000 seepage pipes from 1 to 8 inches in diameter, this flowing soon practically all ceased. At the 1st Av. N. shaft a fault was struck in the lime stone ledge, from which a large amount of water was pumped. Owing to those unexpected difficulties the contractor, who had undertaken the job, failed and the city then continued and completed the tunnel, as it had for five years been building its sewers, thus carrying thru the 1.37 miles of tunnel at a cost of about $202,000, or $28.— per foot.

From the end of the No. Mpls. tunnel at 5th St. and 4th Av. N. a large 7 ft. sewer was built up 5th St. to 8th Av. N. at Bassett's Creek, where it divides into two branches. The smaller branch continues out 5th St. to 10th Av. N., thence turning to Wash. Av. where it extends northward to beyond 20th Av. N. By the aid chiefly of a 2 ft. sewer out Plymouth Av. this river section of North Minneapolis up to 20th Av. N. is drained by this N. Wash. Av. branch.

The larger branch of the 5th. St. N. 7 ft. sewer turns out 8th Av. N. to Dupont Av. N. thence south (for three blocks below the bottom of the straightened Bassett's Creek) to Ontario Av. and turns over to Lyndale. By dividing down Hennepin and Harmon Pl on the one hand and out Hennepin and Lyndale on the other hand it drains the north slope of the bluffs out to Franklin nearly to Nicollet, and the slope towards the bluffs down as far as 13th St. A 4 1-3 ft. sub-branch of this Bassett's Creek sewer has been built (in 1906) from 1st Av. N. and Irving south under the Creek and across its valley on the line of Irving Av. to Laurel Av. in Bryn Mawr. Much difficulty was experienced in crossing this bog. The oval shaped concrete sewer was made on a grillage of timbers resting on piles from 30 to 60 ft. long; while the lateral pressure of the slippery blue clay below the peat caused a tremendous pressure on the sheathing and bracing.

With the planned extension from the present end at Laurel Av. up the Avenue the Bryn Mawr district will get sewerage connections. Another sub-branch is planned from 1st Av. N. and Irving to the Cedar Lake road and up Logan Av. N., to complete the drainage of this northwest section of the city up to about 20th Av. N.

The natural drainage character of this Bassett's Creek Valley and its difficult engineering character as a peat and clay bog without the city's usual underlying foundation of limestone are interestingly explained by our state geologist as due to the former course of the Mississippi river thru this valley. By turning southward from its present bed at its junction with Bassett's creek the Mississippi river once evidently flowed through the present Bassett's creek valley in the city and thru the chain of lakes from Cedar to Harriet, and thence, it is supposed, into the Minnesota river. During the thousands of years of this course of the river the lime stone stratum was worn away and a deep channel was excavated, which was later filled with a deposit of silt and vegetable matter. The advance of the last glacial age blocked this channel and turned the river into its present course from Bassett's creek to Fort Snelling. Only this little creek, then, now remains in this engineeringly troublesome valley and meanders in a reverse direction from the once mighty river which dug out the valley.

The importance of this Bassett's Creek valley is also seen in its size. Within the city limits it drains 2800 acres, or 4.37 sq. miles; while its additional drainage adjacent to the city makes a total of about 25 sq. miles. The volume of water in the creek varies from nothing in a dry season to 1,000 cub. ft. per second in a flood season, with an average of some 10 to 12 cub. ft.

The plan of diverting the creek into Cedar Lake and so out thru the chain of city lakes into Minnehaha Creek would only take off about half of this natural flow. (For a discussion of this proposed divertion of Bassett's Creek see my report "On the Proposed Diversion of Bassett's Creek," presented to the City Council, June 8, 1906). Could this storm water drainage, which will always thus be considerable, be confined into an open or closed channel, as in the straightened portion between Western and 6th Avs. the large region of present bog would undoubtedly be drained dry as Hoag's Lake, between 4th and 6th Avs. ..., was dried up by the North Minneapolis tunnel. Also where a natural means of surface drainage is at hand it is good policy to utilize this means and thus tax the sewer systems only with the house sewerage; as has been done in our Kenwood district where the storm water drains into Lake of the Isles, so that only a 18" pipe from the end of 27th St. around the boulevard is sufficient for the house sewerage.

The further development of the North Minneapolis sewer systems was determined by the establishment in 1889 of the new pumping stations for the city water supply at 42d Av. N. in Camden Place and the later North East Station still higher up the river in 1904, with the consequent abandonment of the old pumping stations at the falls and on the Hennepin Id. Thus the new systems could be again planned for the immediate exits of natural drainage areas directly into the river, without the long and expensive circumlocution of the North Minneapolis tunnel system. Thus in 1890 the 20th Av. N. system was begun from the river foot of that street, extending from the river back to Penn. Av., and draining, with its branches, the region of about 400 acres between 20th and 25th Avs. N. inclusive.

The next northerly section between 26th and 32d Avs. N. was begun by the 26th Av. N. system in 1900, which also extends at present back to Penn. Av. The next drainage area down 33d Av. N. has only as yet been started by a small section back of Lyndale and temporarily emptying into the adjacent lower system. For the next drainage area a trunk sewer will be built this summer from Wash. Av. down 38th Av. N. to the river, for the immediate purpose of making travel somewhat passable for the enormous and heavy wagon traffic of lumber, bricks and farm produce down Wash. Av. thru Camden Place. A still further north system will be started next year on 42d Av. N. The surface deposit of clay all over North Minneapolis makes these rapid extensions of the sewer systems of the utmost necessity in order to drain the many sloughs formed in every pocket depression of the clay, to make the streets passable in wet weather, and to afford house connections where cess pools have no filtration.

The sewer system for North East Minneapolis was begun in the same year, 1889, and with the same plan as the North Minneapolis tunnel system for discharging below the old pumping stations at the falls. A tunnel was begun under the lime rock at the mill race of the Pillsbury A mill at 4th Av. S. E. It extended up Main St. to Marshall, and thence up Marshall St. to 22d Av. N. E. A branch tunnel was made in 1886 up 3d Av. N. E. nearly to Central Av., with a side branch going up 2d St. N. E. to Broadway.

From the end of this 3d Av. N. E. tunnel a 5½ ft. sewer was continued with two main branches, one across Spring St. and up Fillmore, the other turning up Central Av. to 30th Av. N. E. at present. Likewise from the end of the Marshall St. tunnel a large concrete 6½ ft. sewer has been built up 22d Av. N. E. to Monroe, from whence it is planned to cross Central Av. All North East Mpls. is as yet served by only this one system, with its many sub-branches. With the closing of the lower pumping stations however, an overflow has been provided directly into the river at the foot of 3d Av. N. E.

The extreme South East section of the city, below 16th Av. S. E., was provided for by the Oak St. system, begun in 1888 from the foot of Oak St. and turning both ways on University Av., and by the Hamline Av. system, which was built up that hill from the river in 1904 and winds about among the hills of Prospect Park.

These 13 sewer district systems, whose historical development has here been sketched, have grown to a total length of over 200 miles of sewers at a cost of $5,371,567.— Their total capacity is 2260 cubic feet of 16,942 gals. per second with about 1-3 more when overflows are in use. Some idea of the magnitude of this sewer service can be gained when this capacity is compared with a river. This total sewer capacity equals 45% of the average flow of the Mississippi river; or it would form a river 300 feet wide and 3 feet deep, flowing at a velocity of 2½ feet per second or 1.75 miles per hour.

Some appreciation of the present and future necessities of the city can be realized when it is found that the 53 sq. miles of drainage surface within the present city limits is larger than more populous cities like Paris with its 30 sq. miles.

The original construction material of the sewers was sewer brick, except for the small branches from 9 to 15 inches, where cement pipe was used until 1892. Since then vitrified clay pipe has been used instead of cement pipe and has also been found preferable to brick for sewers up to 2 feet in size. The late use of reinforced concrete construction was applied to our 22d Av. N. E. 6½ foot sewer in 1904, and since then has been found less expensive and more satisfactory than brick construction for all sewers larger than 4 feet. Brick is therefore now used only for sewers between 2½ and 4 feet and in all manholes. For catch basins we have also lately began to use concrete.

In connection with the records of our sewer construction for the past 35 years there has accumulated much interesting and valuable scientific data as to the geological foundation of our city, the stratum of blue lime stone . From many records of the elevation of the lime stone it is seen that it varies on the East Side from 133 ft. above city datum at Central and 15th Avs. N. E. down to 102 ft. at Central and Main St., to 75 ft. at the foot of Oak St. and 83 ft. at the foot of Hamline Av. Likewise on the West Side the elevations descend from 120 ft. at 1st St. and 3d Av. N. to 73 at the foot of 11th Av. S. and the same also further south at the foot of 4th St. S., below the Wash. Av. bridge.

There is thus shown a dip in the lime stone ledge from Northwest to Southeast, and of some 60 ft. difference in altitude within the city limits. The thickness of the ledge also varies from 9 to 20 ft. in the N. E. section to 30 ft. in the S. E. and So. section.

The average level of the surface plain of the city near the river is maintained on this sloping rock by the complementary increase of the soil deposits on top of the rock. For, while the lime stone ledge comes quite to, or within a few feet of, the surface in N. E. Mpls. (where the many quarries are), the sloping rock has been covered in the S. E. section and along the west bank of the river with some 40 ft. of sand and gravel.

ENGLACIAL AND SUPERGLACIAL DRIFT IN MINNESOTA, THE DAKOTAS, AND MANITOBA.

By Warren Upham, D. Sc., St. Paul, Minn.

[Abstract of a paper read before the Minnesota Academy of Sciences, December 7, 1909.]

Modified drift, consisting of stratified gravel and sand, with local deposits of clay, overlies the bed-rocks and the till, and generally forms the surface, on an extensive area stretching from St. Paul and Minneapolis northwestward to the lakes at the sources of the Mississippi, and onward to the Rainy river, the southwest side of the Lake of the Woods, and to the vicinity of the city of Winnipeg. The contour of the greater part of these deposits, through their extent of 400 miles, is flat or moderately undulating, and their surface varies in height from a few feet to 50 feet or rarely more above the adjoining lakes and streams. In central Minnesota these tracts of gravel and sand have an elevation that increases from south to north, being 825 to 950 feet above sea level near the Twin Cities, rising gradually to 1,200 feet in the distance of about 100 miles northwest to Brainerd, and ranging from 1,350 to 1,500 feet between the Leaf hills and Itasca lake. Thence their surface sinks to 1,150 to 1,075 feet in the vicinity of Rainy river and the Lake of the Woods, and is between 750 and 875 feet in the district close northeast of Winnipeg, where a part of these deposits forms a remarkable esker, named Bird's Hill.

On each side this broad belt is bordered by areas of nearly the same general elevation, which have mostly a surface of till; and it is to be remarked that the heights of the tracts of modified drift and till are alike determined by that of the underlying rocks, on which these superficial deposits are spread in a sheet of slight depth in comparison with the gradual change in their elevation. The drift sheet on this belt, including both the sand and gravel and the till, probably varies in its average thickness from 50 to 150 feet, while its central portion rises 400 to 600 feet above its south and north ends.

The distribution of the modified drift thus found upon large tracts along a wide belt from St. Paul to Winnipeg, while it is more scantily developed on a still wider region of Minnesota, South and North Dakota, and Manitoba, southwest of this belt, and likewise is scanty or wanting on its northeast side in northern Minnesota and about Rainy lake and the northeast and north portions of the Lake of the Woods, seems to be attributable to converging slopes of the surface of the ice-sheet and the consequent convergence of its currents, which brought an unusual amount of englacial drift into the ice along this belt, and by which also the streams produced in its melting were caused to flow thither from extensive tracts of the ice on the east and west. The glacial striae of these adjoining areas show that on the east the course of the motion and the descent of the surface of the ice-sheet were from northeast to southwest, but that on the west the glacial currents moved and the ice surface sloped toward the southeast.

My studies of the prominent kame called the Devil's Heart hill,[*] on the south side of Devil's lake in North Dakota, and of Bird's Hill,[†] near Winnipeg, convince me that much drift was carried upward into the ice-sheet of this region, to heights of 1,000 to 1,500 feet or more above the ground. The distance from Bird's Hill to the boundary of the glacial drift is about 700 miles to the south and 300 miles to the southwest. It may be estimated, from altitudes of the drift on the White mountains, the Catskills, and the Adirondacks, that the ice-sheet similarly rising over Manitoba attained a maximum thickness of at least one mile, or more probably one and a half miles, about 8,000 feet. The gradients of its surface were similar to the slowly ascending slopes by which the ice-sheets of Greenland and the Antarctic continent rise to altitudes of about two miles above the sea. In the lower quarter or sixth part of the ice covering Manitoba, that is, to a height of probably 1,500 feet, much drift had been carried by its variable and partly rising currents.

Near the border of the ice-sheet during its time of accumulation, little drift could thus be carried into it, and therefore in the melting and recession of that outer part the englacial and finally superglacial drift was generally inconspicuous; but at any considerable distance inside the glaciated area as a score of miles or more, the final melting set free much formerly englacial till and modified drift. The processes of drift transportation and deposition here emphasized were well stated by Prof. N. H. Winchell in 1873,[*] by Prof. C. H. Hitchcock in 1878,[†] and by me in 1876 and 1878 and in numerous later papers and reports.[‡] At the present day these processes are exemplified by the Malaspina glacier or piedmont ice-sheet in Alaska, which during the last century has been much reduced in area and thickness; but the Greenland and Antarctic ice-sheets, which are now constant or increasing by snowfall, have no superglacial drift.

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[*] The Glacial Lake Agassiz, U. S. Geol. Survey, Monograph XXV, 1895, pp. 156, 157.

[†] Ibid., pp. 183-188; also a paper presented to the Geological Society of America, December, 1909, vol. XXI, pp. 407-432.

[*] The Drift Deposits of the Northwest, Popular Science Monthly, vol. III, pp. 202-210, 286-297 (especially page 294, relating to superglacial drift).

[†] Geology of New Hampshire, vol. III, pp. 282, 283, 309, 326, 333-8.

[‡] Proc. A. A. A. S., vol. XXV, for 1876, p. 218; vol. XXVII, for 1878, pp. 299-310. Geol. of N. H., vol III, 1878, pp. 9, 10, 175-6, 285-309. Geol. of Minnesota, Final Report, vol. I, 1884, pp. 440, 603-4; vol. II, 1888, pp. 252, 254-6, 409-417. Am. Geologist, vol. X, 1892, pp. 339-362; vol. XII, 1893, pp. 36-43; vol. XIV, 1894, pp. 69-83; vol. XVI, 1895, pp. 100-113; vol. XIX, 1897, pp. 411-417; vol. XX, 1897, pp. 383-7; vol. XXIII, 1899, pp. 369-374; vol. XXV, 1900, pp. 273-299.

HISTORICAL SKETCH OF THE MINNESOTA ACADEMY OF SCIENCE.

Compiled from its records by Secretary Harlow Gale, for the Thirty-third Anniversary Meeting (278th) January 2, 1906.

The father of the 33-year-old Minnesota Academy of Science is Dr. A. E. Johnson, who conceived the idea of forming a group of Nature-lovers for "the cultivation of Natural Science in general, and especialy the sciences of Geology and Archæology." With two of his professional friends, Drs. Charles Simpson and C. E. Rogers, he issued a public invitation to any persons interested in such a purpose to meet in his office in the Wensinger Block, corner of Central Avenue and Main Street, in St. Anthony, on January 4th, 1873. This invitation brought out three other lovers of nature, Dr. A. F. Elliot, E. W. B. Harvey, Superintendent of the St. Anthony Schools, and Professor N. H. Winchell, who had just come to the University of Minnesota as State Geologist. Two days later an organization was effected, with the presence of two additional physicians, Drs. A. E. Ames and W. H. Leonard, under the adopted name of the "Minnesota Academy of Natural Sciences," whose first officers were as follows:

President—A. E. Johnson, East Minneapolis.
Vice-President—S. C. Gale, West Minneapolis.
Secretary—Chas. Simpson, East Minneapolis.
Corresponding Secretary—A. E. Ames, West Minneapolis.
Treasurer—E. W. B. Harvey, East Minneapolis.

Professor Winchell was the guiding spirit in embodying the organization and drafting the constitution and by-laws; while the offer of Dr. Johnson's office as a place of meeting and for the preservation of specimens was accepted. It is significant of the spirit of the Academy that of the dozen original charter members a majority were practical physicians, viz.: Drs. A. E. Johnson, Chas. Simpson, C. E. Rogers, A. E. Ames, W. H. Leonard, A. F. Elliot and Dr. M. D. Stoneman, a dentist; while only three were teachers, viz.: Professor N. H. Winchell, the State Geologist; Principal E. W. B. Harvey, of the St. Anthony schools, and A. W. Williamson, a teacher of mathematics(for many years now a teacher of English at Augustana College, Rock Island, Ill.) Among the first year's added members, who took an active interest in the thirteen meetings of the year, were R. J. Mendenhall and R. J. Baldwin, bankers and naturalists; William Cheney, our pioneer meteorologist; Dr. P. L. Hatch, our pioneer ornithologist; Dr. W. H. Leonard, Archæology and Botany; Dr. B. L. Taylor, George W. Tinsley, mechanic, and Professor S. F. Peckham, the chemist of the State University. Paris Gibson and O. V. Tousley were among the original trustees.

The first formal paper read to the Academy was Dr. Johnson's able presidential address, "Did Life Originate by Law?" at the February meeting, 1873, which was published before the end of the year as the first number of the first volume of bulletins of the Academy.

In this address of 30 pages the author found it "impossible, in one or a hundred discourses, to present all the evidence that impels us to the belief of the law hypothesis, to the belief that the methods of God are secondary in the control of the universe." The first scientific report was an oral one from Professor Winchell "of his observations of the Drift, presenting the various theories on the subject, together with his own views." Two months later "the Drift was again discussed at considerable length by Messrs. Winchell, J. B. Clough, Ames, Gale and Johnson;" when a query by Dr. Stoneman regarding the identity of matter and force elicited considerable discussion, engaged in to a greater or less extent by all present. The fact that "the question was left undecided, no one being able to see clarly the identity of the two agents or substances" evidently led Dr. Johnson to present a paper two meetings later on "Matter and Force." The last meeting of its first year shows a remarkably virorous Academy, judged from the following minutes. "Dr. Ames read a communication from Professor Leidy concerning a vertebra found by Dr. Ames in the Red River country, assigning it to the Bison antiquus. A report on the Mammalia of the state was read by Dr. Ames (printed in the second number of the Bulletin). A report of the Archæology of the state was read by Dr. Leonard. Mr. Cheney referred to some recent experiments on the effect of vapor of water in equalizing the temperature of a room, which was followed by discussion. A report on the Ornithology of the state was partly read by Dr. Hatch (the balance being read at he next meeting and all printed in the second bulletin.) A paper was read by Dr. Simpson on "Prerequisites to a Proper Study of Science," and was published later.

After an extra supplementary meeting, at which the remainder of Dr. Hatch's report was read and Dr. Johnson read a paper on the "Timbers of the State." the second year of the Academy was begun with a remarkable and valuable paped by Dr. Johnson, designed as his retiring address as President, but really proving to be a new inaugural on the "Geological and Archæological Evidences of the Antiquity of Man" and filling forty pages of the second bulletin. The rest of this bulletin is occupied by a most interesting paper by Professor Winchell on "Geological Notes from Early Explorers in the Minnesota Valley," and by an ingenious paper by Geo. W. Tinsley on "Astronomy—Scientific and Unscientific." The unpublished papers and discussions of this second year should also be recorded here as stimulating evidence of the intellectual activity of the original Academy members. Mr. Tinsley had a paper "On the Cooling of the Earth and Its Relation to the Drift," Dr. Johnson a paper on "Evolution," followed two months later by one from Dr. Ames, who founded his principal argument against the theory on the fact of the existence of the lower forms of life at the present day. The paper drew out a great deal of discussion and revealed the fact that each man held views peculiar to himself." This evolution was again followed by Rev. E. C. Mitchell, who "considered that the two important factors in the origin of species were natural birth and extraordinary generation." Dr. Johnson's indefatigable enthusiasm produced three more papers in the fall of this year: one on "Entomology," one "describing some explorations and discoveries at Palmer

Lake Mound," Brooklyn, Minn., and one "on the Anatomy, Physiology and Habits of the Star Fish." Resolutions were also offered by Dr. Johnson in October of this year (1874) in memory of the death of Dr. A. E. Ames, who had himself offered similar resolutions at the beginning of this year on the death of the distinguished honorary member of the Academy, Professor Louis Agassiz.

The meeting of the third year (1875) began with descriptions by Professor Winchell of the order of the rocks which underlie the surface in this vicinity and by Professor Peckham on the iron ore from Duluth, which was similar to a Rhode Island ore containing a large proportion of titanium. The only paper by Dr. Johnson this year was one in March "On the Stoat, with Special Reference to Its Change of Color." Rev. Mr. Mitchell read "An Essay on Hydrophobia, profusely elaborating the symptoms, real as well as imaginary." R. J. Mendenhall had a paper on "Some Insects Injurious to Vegetation in this Climate," which was published in this year's bulletin "with a view to its wide distribution in our state." The rest of this bulletin for 1875 is occupied with supplementary list of the birds of the state, by Dr. Hatch, with acknowledgements of aid to Mr. John Roberts and his son, T. S. Roberts, W. L. Tiffany and G. W. Tinsley; "Notes on a Remarkable Storm," by Geo. B .Wright, in which over thirty inches of water fell during thirty hours about July 18, 1867; the first installment of Meteorological Statistics by William Cheney, beginning with 1864; "Notes on the Deep Well Drilled at East Minneapolis in 1874-5," by Col. J. B. Clough, City Engineer; and the reports of the committee on Conchology by Dr. Elliot, and of the curator, Dr. Simpson. The fall meetings developed a new and fertile subject when Dr. Leonard "made an interesting report on the examinations of the mounds at Lake Minnetonka in August last, and of the bones found therein, which he placed in care of the curator of the museum." The next month he reported "the opening of a new mound at Crystal lake. A few human bones and the vertebrae of a snake were all that was discovered." A month later Mr. Tinsley "stated that he had discovered thirteen large mounds out at Bloomington, giving a description of them; while at the following meeting Dr. Hatch "gave an interesting account of the opening of a mound by Mr. Thurber at Lake Minnetonka. The mound was covered by stones, placed in the form of a roof, and immediately beneath was a layer of wood, under which was an adult skeleton. One foot below this were four others, making the four points of the compass; one appeared to be an adult male, another an adult female, lying with their bodies horizontal, head slightly raised and legs flexed. The other two were children, with legs flexed in a similar manner, but face down."

The end of this third year marked an important event in the history of the Academy and one which will call our attention to the two other functions of the Academy besides its meetings, i. e., its museum and library. A committee of Drs. Elliott, Hatch, and Simpson, appointed "to take into consideration the propriety of moving the museum of the Academy to a more central location" where it "would be visited by a larger number of people than at present and thereby awaken a greater interest in its prosperity, looked for rooms centrally located about Center block, but they were mostly on the third floor and rents were too high to be easily met by the Academy. The room formerly occupied by the Y. M. C. A., No. 214 Nicollet avenue (over the Post Office) can be obtained for $120 a year. It is of fair size and well lighted; will accommodate the wants of the Academy for a few years very well." Colonel Clough offered to solicit money to finish up the museum cases for which Mr. Tinsley offered the hinges; all of which was done. Thus the meeting of November, 1875, was held in the new rooms.

The museum had begun with gifts of specimens at its organization from Drs. Johnson and Elliot, followed soon by gifts or exchanges from similar societies; so that the curator, Dr. Simpson, in his first report after one year's existence wrote: "Since the Academy took possession of its present rooms, cases have been constructed for the accommodation of our geological and mineralogical specimens, copied from similar cases in the museum of the University of Michigan, which are sufficient, not only for our present collection, but for all that we may reasonably expect to accumulate for some time to come. Ten cases of a different character, with glass covers, intended for the exhibiton of specimens of a more delicate nature, such as insects and shells, have also been procured and partly utilized." The collection then comprised several thousand secimens illustrative of the geology and paleontology of Minnesota, 350 specimens of minerals, a few zoology specimens, about 100 specimens of bones or implements in the archæology of the state, some 300 native Lepidoptera, a few native birds and several hundred land and fresh-water shells. What a stimulating evidence this collection is of the scientific spirit and enthusiasm of the genuine nature-loving founders of the Academy!

The library, with its present 12,000 numbers, began similarly from gifts and exchanges. The corresponding secretary, Dr. Ames, reported at the first May meeting "that he had entered into communication with most of the learned societies of the country;" while the first year's contributions to the library came not only from 164 similar academies of science in California, St. Louis, New York, Buffalo and Philadelphia, but even France, Spain and Scandinavia. The exchanges from our own bulletins now come from every continent of the world.

The fourth year of the Academy's life (1876) was memorable for the publication in that year's bulletin of Dr. A. E. Johnson's monumental paper on "The Mycological Flora of Minnesota," filling a hundred pages. In his genuine naturalist's devotion to this specialty Dr. Johnson had gathered and examined over 10,000 specimens in Hennepin, Ramsey, Wright and Anoka counties, resulting in 559 specimens new to the state, two of which were new to science. Besides this splendid product of the Academy's zeal this bulletin contained Mr. R. J. Baldwin's fine presidential address on "Light," Dr. Leonard's report on "Ferns," Dr. Hatch's supplemental report on "Ornithology," a paper on "Tornadoes and Cyclones" by Gen. T. L. Rosser, "Notes on a Hail Storm Occurring August 18, 1858," by Nathan Butler, and Dr. A. F. Elliot's curator report. Other papers read during the year were "A Case of Plants Adapting their Habits to

Circumstances," by Geo. B. Wright; "On the Detection and Extermination of Several Very Troublesome Insects Among Fruit Trees and Shrubery," by R. J. Mendenhall, Dr. Johnson read a paper giving an account of what was found in the Palmer Lake mounds, General Rosser described the phenomena of falling fish in Kentucky on March 8, 1876, Geo. W. Tinsley read a valuable paper on "The birth and Growth of Planets," Dr. Johnson "gave an interesting and detailed account of how he killed numerous plants with chloroform, which was new to him; but nevertheless convinced him that plants will be killed, as well as animals, from an over dose," and Professor Winchell read a paper as "Notes on the Paleontology of the Trenton Limestone in Minnesota."

These winter months of 1876 make an epoch in the Academy's history through the three public lectures on "Astronomy" by Richard A. Procter, which besides their value as a means of scientific culture netted the Academy treasury $356.60.

Though the scientific activity for 1877 waned somewhat, the following records of papers read show a good vitality: "The Muskrat as the Founder of the Baconian Philosophy," by Geo. B. Wright; "On the Purity of the Water of the Mississippi River," by Dr. Johnson; "On the Tube Artesian Wells of Minneapolis," written by C. E. Whelpley, and read by Dr. Elliot; "Report of the Analysis of Some Ashes Taken from a Furnace where Bran was used for Fuel," by Prof. S. F. Peckham; "The History of Milling," by Geo. H. Christian; verbal report of his investigations in Ichthyology by W. L. Tiffany; a description of the effects of the storm of the previous Friday night in Richfield township by Mr. John Roberts; remarks on the geology of Hennepin county by Prof. Winchell, and "an elaborate account of the ancient as well as modern trilobite by Mr. Tiffany.

The records of the two following year (1878 and 1879) show, amid the presentation of many specimens for the museum and exchanges for the library, the following scientific activity:—two supplementary reports by Dr. A. E. Johnson on the "'Fungi of the State,' of which he had collected 229 species new to our state and 22 new to science (both reports and catalogs being printed in the Bulletin for 1877-9); "An Assay of the Effects of Fungous Growths upon Vegetable and Animal Life," by Dr. Johnson; a paper on "Infusoria," by Dr. A. W. Abbott; a discussion on the recent explosion of the Washburn A mill, by R. J. Baldwin, A. C. Rand and W. L. Tiffany; "An Essay on the Black Bass," by W. L. Tiffany; "Progress in the Study of the Mounds of the State," by Nathan Butler; a paper on "Drilling Wells for Water Purposes," by C. E. Whelpley; a paper on "Ornithological Notes," by Thomas S. Roberts, Robert S. Williams and Clarence L. Herrick, and read by Mr. Tiffany; a paper on "Entomology," by R. J. Mendenhall, and one on "The Yeast Plant," by Dr. A. W. Abbott (both these papers appear only in abstract in the bulletin because all the manuscript and printed pages of the 1878 bulletin were destroyed in the Brackett Block fire); a lecture on "Ethnology," by Hon. C. S. Bryant of St. Paul; a lecture on the Mineralogy and General Geographical Features of the Lake Superior District," by Prof. S. F. Peckham; a lecture on "The Eagle

Fish Hawk," by W. L. Tiffany, the secretary; address on the "Uses of the Misroscope," by Wm. Kilgore, and a paper on "Darwinism," by Professor Winchell, who was president for this year (1879.) Although this paper on Darwinism, along with Dr. Johnson's inaugural address of this year was evidently lost in the historic Brackett Block fire. Professor Winchell's retiring address closes the first volume of over 400 pages of the Bulletin and is a most valuable document on the first seven years of the Academy's history on its purposes and benefits. It ought to be quoted in full in the present historical paper. Besides the men whose names which have appeared as partaking in the Academy's programs there should be mentioned the names of three honored clergymen who took much active interest in the Academy, Jas. McGolrick, Henry A. Stimson and E. S. Williams, the first of whom was the first life member of the Academy, R. J. Mendenhall being the second.

The year 1880 shows the following intellectual scientific activity:—an inaugural presidential address by Dr. P. L. Hatch, reviewing with his well-known literary originality the work of the Academy a letter from C. E. Whelpley, reporting the discovery of wood and bone at a depth of 300 feet during the boring of a well at Sheldon, Iowa, from which the specimens themselves were also sent; "an evening was devoted to microscopy, ten instruments being present, several of which were described in detail by their owners," and a box of microscopic slides, recently purchased from Mr. John Walker, were evidently used; Professors Peckham and Winchell described successively the various specimens in the fine collections of minerals presented by Mr. W. A. Morey for the use and benefit of the Academy;" a similar description, with the aid of Professor Hall, of a collection of minerals given by Mr. C. H. DuBois; "A Biographical Notice of a Few of the Fishes of the Falls of St. Anthony," by Mr. Tiffany; a paper on "How the United States Fish Commission Works," by Franklin Benner, who was connected with this work in Maine in 1878; an address by Dr. R. J. Taylor of Galesburg, Ill., on "The Rotary Motion of the Gyroscope," which address was candidly recorded with the characteristic honesty of the secretary, T. S. Roberts, as being of "little force and unscientific;" an article on the "Copper Mines of Lake Superior," by Professor Winchell, who also discussed the mound builders in connection with the ancient copper mines at Isle Royale, and at two later meetings; Mr. Whelpley described the sand and rock layers, which he presented to the Academy, taken from the artesian well at the Washburn A mill; Warren Upham "spoke of the glacial terminal moraine, which he had spent his time the past summer and fall in examining, and an article on "Red Lake Notes" was transmitted to the Academy and printed in its bulletin from Miss Franc E. Babbitt of Little Falls, together with her sending a box of pottery fragments from this region. In connection with this first mention of a woman in the Academy's proceedings it should have been recorded before that Mrs. F. L. Tinsley, wife of Geo. W. Tinsley, had been elected the first woman member in March, 1876. Mrs. Tinsley had presented the Academy a month before with thirteen mounted bird skins, which she had herself prepared and for which she was voted thanks "for the valuable specimens presented, prepared, as they were, with artistic skill."

The year 1881 opened with a paper from Mr. Charles Hallock of Hallock, Minn., former editor of "Forest and Stream," on "The Fauna of Northern Minnesota," read by A. B. Jackson and published in the Bulletin. "Mr. T. S. Roberts read an interesting paper upon "The Orchids of Minnesota," speaking first of the peculiarities of the family in general and the various curious adaptations for cross fertilization, the writer directed his attention to the orchids native to the state, of which thirty-two species have been identified. Taking them up in the order of Gray's Botany, each of these was briefly described, with additional notes upon peculiarities, habits, etc" (From the record of the secretary, C. L. Herrick, as the paper was unfortunately not published.) "President Winchell read a paper entitled "Where did Carver Winter in 1766?" Carver's account was shown to be vague and in some respects unreliable. He was in search of the 'Northwest Passage to Asia.' He says he ascended the 'Minesotay' 200 miles, which is an evident exaggeration. Evidence seems to point to the mouth of the Cottonwood river as the actual site of this disputed locality. The paper elicited questions and remarks. Mr. Upham, in response to question, said that he found several evidences of two glacial epochs in the portions of the state which he had examined: First, vegetable remains in situ between layers of boulder clay, also fresh-water shells under the same circumstances; second, terminal moraines in succession. He also spoke of the evidence that there had been more than two such epochs. The universal prevalence of glaciation indicates the astronomical origin of glacial epochs. In response to a question from Mr. Gale, Professor Winchell restated briefly the method by which he had estimated the time since the last Glacial epoch by the data afforded by the recession of the Falls of St. Anthony." (All from March, 1881.)

Mr. Chas. Hallock then gave a personal lecture upon "Fish and Fishing," illustrating his remarks by exhibiting the various paraphernalia of the sport. On motion of Professor Hall the Academy "requested Professor Weitbrecht of St. Paul, Professor Gray of St. Cloud, Professor Boutelle of Winona and Dr. C. N. Hewitt of Red Wing to collect data in reference to the recent and earlier floods of the Mississippi and Minnesota rivers and other waters of the state, in order to made a permanent record of the floods which periodically devastate the state." (July, 1881.) The last meeting for 1881 was held in the new room to which the Academy had moved, back again in the Wensinger Block, 100 Central avenue, where the rent was $100 per year, and insurance for $500 was placed on the collections.

The year 1882 began with Professor Winchell's retiring presidential paper on "The Geology of Minneapolis," the same being a report on the product of the drilling of an artesian well at the Washburn A mill and comparing it with the various geological formations throughout the state." "From the section of Astronomy Judge N. H. Hemiup, Chairman, read an interesting paper on 'The Other Side,' drawing conclusions from the writings of astronomers concerning the actual physical condition of the moon," calling forth much discussion from Professors Winchell and Downey. "Warren Upham read a very able and elaborate paper on 'The Flora of Minnesota,—Its Trees, Fruits, Flowers and Weeds,' at the March meeting in spite of its adjourning prematurely in consequence of the uncomfortable condition of the hall from cold." "Professor Dodge gave a very full description of some tests of building stones being made in the chemical laboratory" of the University; and "Professor Pearson then read a paper entitled 'Carbonic Acid in the Air.' The paper embodied experiments and results of a series of investigations made by the author a few years ago in and near Boston, Mass." (April meeting.) Both these papers were followed by much discussion on the part of Professor Pike and Dr. W. H. Leonard respectively. The May meeting was memorable for the splendidly able paper by Dr. A. E. Johnson on "Whence came the Differnt Species of Varieties of Man?" published later in the Bulletin and which proved to be the last of the eighteen monumental papers by the "Father of the Academy." His absorbing devotion and study of his fungi, especially his excessive use of his microscope by lamp light by which he nearly lost the sight of one eye, had already begun to break down his health; sciatic rheumatism also began to cripple him. So that from about this time he gave up his practice as a physian and began the long series of invalid years of which he has now almost reached the end. This paper of Dr. Johnson's on the evolution of man was immediately followed by Professor Winchell's fine tribute to Charles Darwin in the shape of resolutions on his death (printed in the Bulletin,) and Judge Hemiup was appointed to prepare a memoir on the life and works of Darwin.

After some discussion at the June meeting "on insects injurious to shade trees, especially the elms of the city," Mr. C. L. Herrick gave the Academy some notes of his stay in Europe during the preceding months, and "Mr. J. Walker called attention to a peculiar infusorium recently observed by him, etc." A special meting was called to extend an invitation, in conjunction with the enlisted aid of the Board of Trade and officials of the city, to the American Association for the Advancement of Science to hold its next yearly meeting in Minneapolis; but this invitation could not be accepted. "Professor Winchell read a paper on 'The Bibliography of the Mineralogy of Minnesota,' with a list of minerals found in the state, with their chief localities." (Published in the Bulletin.) At the November meting "an interesting paper was read by John Walker, chairman of the section of Microscopy, giving a review of the field studied by the section during the past year. The work covered observations on Entomostraca, micro-botany; especially Equisetum spores and outer cells of Utricularia vulgaris, the micro-fungi, fresh-water algae, diatoms, also Infusoria, rizopods and other divisions of the Protozoa, articulates, etc." The last meeting of 1882 found the Academy and its museum again on the West Side, after only one year's second sojourn on the East Side, having rented a room 44x80 on the third floor of Anthony Kelly's Block, 110 Hennepin avenue, at $150 per year. The expense of moving, finishing the room and fitting up of new cases for these quarters was largely met by the activity and generosity of Mr. T. B. Walker, who had been a member of the Academy since February, 1879, had been chairman of the sections of

Geology and Astronomy and had been a trustee, in company with Jas. McGolrick, among others, since January, 1882. There should be recorded with gratitude the fact that this year of 1882 marked the beginning of Dr. A. F. Elliot's eight consecutive years of able leadership as president and of Professor C. W. Hall's fourteen laborious and efficient years as recording secretary. Besides the papers already mentioned as recorded in the meetings for 1880-1882, inclusive, the following papers or abstracts are printed in Vol. III of the Academy's Bulletin covering these three years:

"The State and Higher Education," inaugural address of 1881, by President N. H. Winchell.

"Some Impurities in Drinking Water," by Prof. Geo. Weitbrecht, of the St. Paul Medical College.

"Industrial Education," by Prof. W. A. Pike, of the University of Minnesota.

"Influence of Geological Structure on History in the United States," by Prof. A. F. Bechdolt, of the Mankato Normal School.

"Is the Dakota Related to the Indo-European Languages?" by A. W. Williamson, Ad't Professor of Mathematics of Augustana College, Rock Island, Ill.; formerly one of the original charter members of the Academy.

"The Classification of Languages" and "The True Method of Political Economy," both by President W. W. Folwell, of the University of Minnesota.

"The Fixed Stars," by Prof. J. F. Downey, of the University of Minnesota.

"Some Theories of the Origin of Meteorites," by Prof. C. W. Hall.

"The Spectroscope in Astronomy," by Prof. W. W. Payne, of Carlton College.

"The Duty of Scientific Societies to Aid in Practical Sanitary Work," by Dr. C. N. Hewitt, Secretary of the State Board of Health and Professor of Public Health in the University of Minnesota.

"Some Observations of Living Cells," by Prof. S. Calvin, of the State University of Iowa.

"Joseph Priestly," by Prof. James A. Dodge, of the University of Minnesota.

"Natural Sciences in the Public Schools," by Prof. A. F. Bechdolt, of the Mankato Normal School.

"Physiology and Mental Science," by Prof. A. T. Ormond, of the University of Minnesota.

"The Utilization of Sawdust," by Prof. J. A. Dodge.

"Lake Agassiz: A Chapter in Glacial Geology," by Warren Upham.

"The Physical Character of the Sun," by Prof. J. F. Downey.

"A Study of Recent Comets," by Prof. W. W. Payne.

"Some Algae of Minnesota Supposed to be Poisonous" and Descriptions of Iowa Uromyces," both by J. C. Arthur.

"Notes on Some Pieces of Pottery, and Native Alum from White Fish Lake," by C. W. Hall.

"On the Oxidation of Benzine Derivations with Potasium Ferri-Cyanide and Caustic Potash," by W. A. Noyes.

"Meteorological Statistics for Minneapolis from 1865 to 1882," by Wm. Cheney.

There is fortunately no further necessity of continuing this catalog of the papers and discussions of the Academy beyond these first ten years of its existence, for from this time on an outline of the Secretary's record book has been printed as "Proceedings" through the third and fourth volumes of the Bulletin. For this valuable innovation the Academy is indebted to its faithful Secretary and President, Prof. C. W. Hall. As we can therefore trace the personnel and amount and character of the scientific activity of the Academy so easily to the present time through its printed records, there only remains the mention of two important historical events in the Academy's life.

Already in February, 1880, President Hatch had "called the attention of the Academy to a proposition to erect a building which it was proposed to consider at this time, concluding by calling upon Mr. R. E. Grimshaw to present the matter more fully." On Mr. Grimshaw's motion that a committee of five be appointed to consider the whole subject of the erection of a building he was appointed chairman and associated with T. B. Walker, S. C. Gale, A. B. Jackson and N. H. Winchell. Nothing more is said in the records of this plan until November ,1884, when it was resolved through Professor Winchell's motion, "That it is the sense of the Minnesota Academy of Natural Sciences that there should be erected a joint building for the accommodation of the Academy, the Athenaeum and the Art Association, and that this Academy will gladly co-operate with any parties who may inaugurate a general movement to secure this event." This resolution immediately followed mysterious "communication by Judge Hemiup, having reference to a public building to be built for uniting the place of meeting of this Academy and the Athenaeum." Judge Hemiup moved that a committee of three, of whom Dr. Elliot should be one, be appointed to consider the matter in confernce with the trustees of the Athenaeum with a view to solicitation of funds from the public. The matter was further brought forward in a letter read by Judge Hemiup from (name withheld) a friend of the Academy. Dr. Elliot then associated with himself in this committee T. B. Walker and S. C. Gale.

But the "Public Library" plan for the co-ordination of these three public educational functions of literature, art and science was finally executed, and on October 8, 1889, "the Academy met for the first time in its new quarters in the Public Library Building; fifty persons were present." The meetings began there regularly on January 15, 1890, when Dr. Hatch moved that a vote of thanks be extended to the Library Board of the City of Minneapolis "for their prompt and generous action in affording quarters for the Academy and in furnishing cases for the preservation and exhibition of its collections. Mr. Edward Gale, in seconding the motion, spoke in warm and hearty words the appreciation of the institution for the ready and cheerful action of the Library Board towards the Academy. The motion was unanimously carried." But before the Academy could get away from the Kelly Block, Mr. Walker again came to its rescue by contributing $125 toward the $175.81, which Father

McGolrick's peaceful and faithful service as trustee had at last effected as a settlement of the two years' arrears of rent with Mr. Kelly.

The other historical event is the "Menage Scientific Expedition to the Philippine Islands," the inception and history of which is told in the Bulletin "Proceedings" from April 8, 1890, to November, 1894, in the "Preliminary Notes on the Birds and Mammals Collected by the Menage Expedition," which form sixty-four pages of the first issue of "Occasional Papers" of the Academy, and in the "Letters from Dean C. Worcester and Frank S. Bourns, forming the Menage Expedition," in pages 131-172 of Vol. IV. of the Bulletin.

The collections of this expedition have become celebrated. They embrace a beautiful group of stuffed orangs, said to be the best in existence, other Philippine large animals, numerous alcoholic specimens used by the Zoological department of the University of Minnesota, and the finest and largest collection of Philippine bird-skins extant, the last loaned by the Academy to the Honolulu Museum and used by Mr. Bryan in his work on the birds of the Pacific ocean.

The project of this expedition was brought to the attention of the Academy by Mr. H. V. Winchell, a college friend of Messrs. Worcester and Bourns. Mr. Menage was visited by thes three enthusiasts, and on condition that the Academy would house and care for the collection, Mr. Menage contributed ten thousand dollars for expenses.

I cannot close this historical sketch of the Academy of Sciences without recording a couple of practical inferences which have grown out of my leisurely traveling through the Academy's history. The first inference is that the Academy's foundation strength lies in a love for the knowledge of nature right about us, especially of our own state. This love of nature for her own sake, stimulating vigorous physicians, business men and teachers to use their own senses and hungering intelligence to know about the plants, birds, fish, waters, woods, prairies, rocks, bones and pottery,—all this to better understand our own individual relations to the world of nature and man right about us,—such was the strong character of the founders of the Academy thirty-three years ago, and such intellectual interests have made the honorable and useful record of the Academy's first generation of existence. When the Academy has become weakened or desiccated, the cause is evident in the loss of this love of nature and the introduction of the spirit of scientific professionalism. For there is a professionalism of science as well as of bodily exercise. When a student of nature becomes so morbidly developed that his main interest is in displaying his accomplishment or prowess, in collecting an ingenious armor of apparatus for his specialized kind of scientific warfare, and then takes his chief scientific exercise in beating his competitors for good salaried positions,—such a scientific athlete crushes out the modest love of nature—not but that microscopic specialists must exist in the machinery of a true university, or but that much genuine amateur disinterested love of scientific exercise is scattered here and there among the professional positions; and the Academy ought to be deeply grateful for the constancy and efficiency of such well-tried experience as it has had the good fortune to gain. But its second generation of life, judged from its first, must find its main nourishment in the amateur spirit of voluntary intellectual exercise for one's own stronger scientific manhood.

The second inference is as to the most efficient methods of exercising this love of nature. First by each member's bringing into the monthly meetings the finds in nature which have given him personally the greatest satisfaction. Then by exchanging these nature-discoveries the members were mutually educated in the highest way, —better than any cut and dried formal course of study could do. The bringing in of real specimens for the museum, describing them informally and untechnically, was the best stimulus for each member's learning more in his special field of nature. The wider perspectives of the application of all these bits of knowledge to ourselves, as preeminently gathered up in the great world-law of evolution, has often been presented most ably in the presidential addresses. And the most that any guiding officer could do was in aiding or arranging the meetings for discussions and papers; his most strenuous official fidelity is unavailing without a homogeneous body of real lovers of and workers in nature. If the contribution made a fairly complete chapter or even paragraph of knowledge they printed their papers themselves to exchange with similar all over the world. Here again they happily avoided a professionalism which, often under the glamor of artificial light or obscurity, too often extracts money from spectators to pay for publishing their personal victories. The range of the Academy's collected studies thus naturally confined itself to the knowledge of the nature of our own community and state; similar scientific societies in other cities and states making their local studies and exchanging with Minneapolis and Minnesota. The more abstract, technical, or ultra-scientific papers found little expression in the four volumes of the Academy's Bulletins; such articles should go to the few highly specialized scientific journals.

Then, besides being a mutual knowledge-exchange, the Academy made itself helpful to a larger circle through the educational means of its public museum and public lectures. Both these public functions have done much for the intellectual culture of our city. They require more financial support than the publishing function; but, when any necessary or reasonable plans for museum growth or popular scientific lectures were made, there has been a timely and generous support from public-spirited men of intellectual and business force of character. Where there has been scientific ideals and determination the money has never failed. Thousands of children and adults have gotten educational culture from the Academy's collections of the works of nature and of nature's children, or from the Academy's public lectures on astronomy or physiology. Along with the rich opportunities for literary and art culture which our city generously offers to its children and citizens there is also the indispensable need for the complementary side of human culture in knowing nature about us at first hand. And this function the Academy's museum and public lectures can fulfill as none of our other educational means in schools and colleges try or can hope to do.

Thus it is profoundly to be hoped that the spirit of loving to know about nature for her own sake and the executive ability for

pursuing this knowledge for its own culture-value to themselves and to the community may be sacredly honored, preserved and extended in the life of the Academy.

LIST OF ACCESSIONS TO THE LIBRARY BY EXCHANGE FOR THE YEARS 1905-1909.

Prepared by O. W. Oestlund, Corresponding Secretary.

Aarau, Switzerland.—Aargauischen naturforschenden Gesellschaft zu Aarau. Mitteilungen: X; XI.

Adelaide, South Australia.—Royal Geographical Society of Australasia, Proceedings: VIII.

Agram, Hungary.—Jugoslavenska Akademija.
Ljetopis: XIX-XXIII. Rad. 158-161, 163, 165, 167, 169, 171, 173, 175, 177.

Albany, N. Y.—State Educational Department: Annual Report, I, II.
State Library: Bulletin, Nos. 86, 87, 91, 93, 97, 99, 100.
State Museum: Annual Report, 56, 57; Bulletin, 77-87, 89, 91, 93-97, 99, 100, 102.
University of N. Y. Annual Report, 1905.

Altenburg, Germany.—Naturforschende Gesellschaft des Osterlande.
Mitteilungen: XI, XII, XIII.

Amiens, France.—Société Linnéenne du Nord de la France.
Bulletin: XV-XVIII; Memoires, XI.

Ann Arbor, Mich.—Academy of Science. Reports: I-VI, IX, X.
University of Michigan. Bulletins, 1905-1909.

Austin, Texas.—Texas Academy of Science. Transactions: IX, X.

Baltimore, Md.—Johns Hopkins University. Circulars: 1905-1909.

Baltimore, Md.—Peabody Institute. Annual Reports: 38, 41.

Bamberg, Germany.—Naturforschende Gesellschaft in Bamberg.
Bericht: XIX, XX.

Barcelona, Spain.—Real Academia de Ciencias y Artes de Barcelona.
Boletin: II: 6-11. Memorias: V, 2-27; VI, 1-33; VII, 1-17; VIII, 1-6. Nomena: 1904-1908.

Basel, Switzerland.—Naturforschende Gesellschaft in Basel.
Verhandlungen: XV, 3; XVI-XIX; XX, 1.

Belfast, Ireland.—Natural History and Philosophical Society.
Report and Proceedings: 1903-1906.

Bergen, Norway.—Bergens Museum. Aarsberetning: 1904-1906. Aarsbog: 1904: 2, 3. 1905; 1906; 1907: 1, 2. Meeresfauna von Bergen; I-III.

Berkeley, Cal.—University of California.
Publication: I: 8; II: 1-2. Chronicle: X, 3, 4.

Berlin, Germany.—R. Friedländer & Sohn.
Naturae novitates: 1904, 19-24; 1905-1908; 1909, 1-6.

Beiers, France.—Société d' Etude des Sciences Naturelles de Beziers.
Bulletin: XXVI-XXIX.

Bogota, Colombia.—Ministerio de Obras Publicas.
Revista: I, 8-12; II; III; IV, 1-9.

Bologna, Italy.—Reale Accademia delle Scienze dell' Instituto di Bologna. Memorie: Ser. 5, X; Ser. 6, I-V. Rendiconto: VII-XII.

Bombay, India.—Royal Asiatic Society. Bombay Branch.
Journal: XXII; XXIII; Centenary Memorial Volume.

Bordeaux, France.—Faculté des Sciences, Laboratoire de Botanique.
La Diatomie Biene.

Boston, Mass.—American Academy of Arts and Sciences.
Proceedings: XL, 11-24; XLI, 1-35; XLII, 1-29; XLIII, 1-21; XLIV, 2, 3, 6-26; XLV, 1.

Boston, Mass.—Boston Society of Natural History.
Proceedings: XXXII, 3-12; XXXIII, 2-9; XXXIV, 2-7.

Boston, Mass.—Massachusetts General Hospital.
Publications: I, 1-3; II, 1. The fruits of medical research, C. W. Eliot. A consideration, etc., W. H. Walsh.

Boston, Mass.—Massachusetts Horticultural Society.
Transactions: 1904, 2; 1905-1907; 1908, 1.

Boulder, Col.—University of Colorado. Dept. Psychology: II, 2, 3; III, 1, 2. Studies: II, 3, 4; III-VI.

Bozeman, Mont.—Montana Agricultural College.
Science Studies: I, 1-3.

Braunschweig, Germany.—Verein für Naturwissenschaft.
Jahresbericht: XIV.

Brisbane, Queensland.—Geological Survey of Queensland.
Publications: Nos. 196-205, 207-212, 214-216, 219.

Brisbane, Queensland.—Royal Society of Queensland.
Proceedings: XIX, XX.

Brooklyn, N. Y.—Brooklyn Institute of Arts and Sciences.
Cold Spring Harbor Monographs: I, 3-7 9, 10.
Science Bulletin: I, 4-8, 11-16.

Brunn, Austria.—Naturforschenden Verein in Brunn.
Verhandlungen: 42. Bericht: 22.

Bruxelles, Belgium.—Société royale de Botanique de Belgique.
Bulletin: XLI-XLV.

Bruxelles, Belgium.—Société belge de Microscopie.
Annales: XXVI, XXVIII.

Bruxelles, Belgium.—Société Royal Zoologique et Malacologique de Belgique. Bulletin: 1903-1906.

Bruxelles, Belgium.—Société Scientifique de Bruxelles.
Tables analytique des Annales et Revue, 1875-1901.

Budapest, Hungary.—Ungarische Ornithologische Centrale.
Aquila: XI-XV.

Buenos Aires, Argentina.—Ministerio de Agricultura de la Republica Argentina. Boletin: VII, 3; VIII, 3, 4; IX, 1, 2.

Buenos Aires, Argentina.—Museo Nacional de Buenos Aires.
Annales: V-X.

Buenos Aires, Argentina.—Sociedad Cientifica Argentina.
Anales: LVIII, 4-6; LIX-LXVI; LXII, 1-5.

Calcutta, India.—Geological Survey of India.
Himalaya Mts. and Tibet: I-IV.
Memoirs: XXXII, 4; XXXIV, 4; XXXV, 3; XXXVI, 1, 2.
Palaeontologia Indica: II, 2-5; III, 3; V, 1-3.
Records: XXXI, 3, 4; XXXII-XXXVII; XXXVIII, 1, 2.

Cambridge, Mass.—Harvard College Observatory.
  Annals: XLVII, 1; L; LII, 2; LIII, 5-9; LIV; LV, 1; LVI, 1-4; LVII, 1, 2; LIX, 1, 2; LX, 1-5, 9; LXI, 1; LXII, 1; LXIV, 1-3.
  Annual Reports: 1904-1906.
  Circulars: 88-142.
Cambridge, Mass.—Museum of Comparative Zoology.
  Bulletin: XLVIII, 3.
Cameron, La.—Gulf Biological Station.
  Bulletin: 7 and 13.
Cape Town, South Africa.—South African Philosophical Society.
  Transactions: XIII, pp 289-546; XV, 3-5; XVI, 1-5; XVII, 1; XVIII, 1-4.
Cassel, Germany.—Verein für Naturkunde.
  Abhandlungen und Bericht: XLIX-LI.
Catania, Italy.—Accademià Gioenia di Scienze Naturali.
  Bollettino: LXXXIII-LXXXVIII.
Chapel Hill, N. C.—Elisha Mitchell Scientific Society.
  Journal: XXI-XXV.
Chatham, N. B., Canada.—Miramichi Natural History Association.
  Proceedings: No. 5.
Chicago, Ill.—Chicago Academy of Sciences.
  Bulletin: III, 1, 2; IV, 2; VI; VII, 1. Special Bulletin No. 2.
Chicago, Ill.—Field Columbian Museum.
  Publications: 94, 98, 101, 104-134.
Chicago, Ill.—John Crerar Library.
  Annual Reports: X-XIV.
  List of Cyclopedias and Dictionaries. A list of books exhibited.
  Handbook, 1907. List of books in reading room.
Christiania, Norway.—Videnskabs Selskab i Christiania.
  Forhandlinger: 1904-1908.
  Skrifter: 1904-1908.
Chur, Switzerland.—Naturforschende Gesellschaft Graubündens.
  Jahresbericht: XLVII-LI.
Cincinnati, Ohio.—Cincinnati Society of Natural History.
  Journal: XX, 5-7; XXI, 1.
Cincinnati, Ohio.—Lloyd Library of Botany.
  Bulletin: VII-XI.
  Mycological notes: XV-XXIX.
Colorado Springs, Colo.—Colorado College.
  Publications: 24-26; 29-33; 36, 37, 39, 42, 44.
Columbia, Mo.—Laws Observatory.
  Bulletin: II-XVI.
Columbia, Mo.—University of Missouri Library.
  Bulletin: VIII, 5.
  Studies: I, 1, 2; II, 1.
Columbus, Ohio.—Geological Survey of Ohio.
  Bulletin: II-VIII.
Concarneau, France.—Laboratoire Maritime de Concarneau.
  Travaux scientifiques: I, 1-5.

Davenport, Iowa.—Davenport Academy of Sciences.
Proceedings: IX-XI; XII, pp. 95-222.

Denver, Col.—Colorado Scientific Society.
Proceedings: VII, pp. 341-346; VIII, pp. 1-422; IX, pp. 5-258.

Des Moines, Iowa.—Geological Survey of Iowa.
Annual Report: XV-XVIII.

Des Moines, Iowa.—Iowa Academy of Science.
Proceedings: XII-XV.

Dorpat, Russia.—Naturforscher Gesellschaft bei der Universität Jurjew.
Archiv: XII, 3; XIII, 1.
General Register zu I-XIV. Namenregister, III-XIV.
Schriften: XIII-XIX.
Sitzungsberichte: XIII, 3; XIV-XVII.

Dumfries, Scotland.—Natural history and Antiquarian Society.
Transactions: XVII, 3-5; XVIII-XX.

East Lansing, Mich.—Michigan State Agricultural College.
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REVISED CONSTITUTION AND BY-LAWS OF THE MINNESOTA ACADEMY OF SCIENCE.

December, 1910.

Article I. NAME.

This Association shall be known as The Minnesota Academy of Science.

Art. II. OBJECT.

It shall be the object of the Academy to observe and investigate natural phenomena; to make collections of specimens illustrating the various departments of science; to name, classify and preserve the same; also to discuss such questions as shall come within the province of the Academy.

Art. III. PLACE OF MEETING.

The place of meeting of the Academy, and the location of its cabinet and library shall be in the City of Minneapolis.

Art. IV. OFFICERS.

The officers of the Academy shall consist of a President, Vice-President, Secretary, Corresponding Secretary and a Treasurer, who shall be elected annually by ballot by a majority of the members present.

Art. V. TRUSTEES.

There shall be a Board of Trustees, which shall consist of six members, two of whom shall be elected annually, and the President and Vice-President of the Academy.

Art. VI. ELECTION.

The election of officers and trustees shall take place on the first Tuesday after the first Monday of January in each year.

Art. VII. FEES.

All persons residing in the cities of Minneapolis or St. Paul, elected members of the Academy, shall pay an initiation fee of three dollars; and all persons elsewhere in the State such an initiation fee as the Academy may determine.

BY-LAWS.

Article I. MEETINGS.

Section 1. The annual meting of the Academy shall be held on the first Tuesday after the first Monday of January in each year.

The regular monthly metings of the Academy shall be on the first Tuesday after the first Monday of each month. Five members shall constitute a quorum.

Sec. 2. The meetings of hte Board of Trustees shall be quarterly on the days following the corresponding monthly meetings of the Academy; Provided, that the President shall have power, at his discretion, to postpone any quarterly meeting except the first in each year, and to call special meetings at the request of three members of the Board.

Sce. 3. The President, at the written request of five members, may call a special meeting of the Academy, but no business shall be transacted at such meetings, except that for which they were called.

Art. II. SECTIONS OF THE MEMBERSHIP.

Section 1. The entire membership shall be divided into sections corresponding to the branches of science, each section being in charge of a chairman appointed by the President, and all vacancies shall be filled by him, subject to confirmation by the Board of Trustees. Each section shall consist of the chairman and as many members as desire to work in it. The chairman shall divide his section into as many sub-sections as will best subserve the objects of the section.

Sec. 2. The sections shall cover the following sciences:

ANTHROPOLOGY.
ASTRONOMY.
BIOLOGY.
BOTANY.
CHEMISTRY.
GEOLOGY.
INVERTEBRATE ZOOLOGY.
MINERALOGY.
MICROSCOPY.
MECHANICAL PHILOSOPHY.
PHYSICS.
ECONOMICS AND SANITARY SCIENCES.
VERTEBRATE ZOOLOGY.

Sec. 3. There shall be a Committee on Finance and one on the Museum and Library, to consist of three members each.

Art. III. DUTIES OF OFFICERS.

Section 1. The President shall preside at all meetings of the Academy, and at each annual meeting the retiring President shall deliver an address before the Academy on such subject, covered by the scope of its investigations, as he may select—such address to be preserved in the records of the Academy.

Sec. 2. The Vice-President shall preside at meetings of the Academy and act as president in all respects in the absence of the President.

Sec. 3. The Secretary shall keep correct and accurate minutes of the proceedings of the Academy; receive all moneys, and pay them over to the Treasurer and take his receipt for the same; and enter in the proceedings of the Academy the name of each person paying money to him, the purpose for which the same is paid, and the amount paid, and make out in writing and submit to the Academy a correct and accurate statement, in detail, of his official account with the Academy, which statement shall be submitted at the annual meeting; he shall deliver all books and papers in his possession having any reference to the proceedings of the Academy, to his successor in office.

Sec. 4. The Corresponding Secretary shall conduct the correspondence of the Academy.

Sec. 5. The Treasurer shall receive all moneys from the hand of the Secretary, and give his receipt for the same, and shall pay them out on the order of the President, countersigned by the Secretary; and for the faithful performance of his duties, he shall, every year- before entering upon the duties of his office, give a bond for such amount as the Board of Trustees shall determine, such bond to be signed by himself and two sureties; and shall, also, prepare an accurate statement, in detail, of his accounts, and submit the same to the Academy at its annual meeting and shall deliver all books, papers and vouchers in his possession, having any reference to the financial condition of the Academy, to his successor in office.

Sec. 6. The Curator of the Museum shall be appointed by the Board of Trustees. He shall be one of the Committee on Museum, and shall have the custody of the collections belonging to the Academy; shall receive, label and arrange the specimens that may be added to it from time to time, and present annually a report, stating the number and kind of additions to the Museum, and their source. He may, also, present a memoir on any department illustrated by the collections.

Art. IV. DUTIES OF COMMITTEES.

Sec. 1. The chairmen of the sections shall have charge of the departments to which they are appointed, and shall prosecute such investigations as they may see fit. any member offering to the Academy at its regular meetings such remarks, written or oral, as he may think of interest. They shall also collect and preserve for the Museum, specimens illustrating their several branches.

Sec. 2. The Financial Committee shall audit the accounts of the Secretary and Treasurer at the end of each year, and all other accounts referred to them by the Board of Trustees, or by vote of the Academy.

Art. V. DUTIES OF THE BOARD OF TRUSTEES.

Section 1. The Trustees shall hold in trust all property, real and personal, belonging to the Academy, or which may hereafter be acquired by purchase, gift, or otherwise, except as otherwise directed by the Academy.

Sec. 2. They shall cause to be published such transactions of the Academy as they may see fit.

Sec. 3. They shall secure the delivery of public lectures when, in their opinion, it may be expedient.

Sec. 4. They shall appoint and remove at pleasure, all agents and employees of the Academy, prescribe their compensation and fix their duties.

Sec. 5. They shall fill all vacancies in the Board; and members thus elected shall hold office until the next annual meeting of the Academy.

Art. VI. WRITTEN COMMUNICATIONS.

All memoirs and written communications made to the Academy at its regular meetings, by any of its members, shall be preserved in the records of the Academy.

Art. VII. MEMBERSHIP.

Section 1. Any person may be elected to active membership by a vote by ballot of two-thirds of all the members present at any regular meeting, after the payment of the required initiation fee and on being recommended in writing by three members, and may participate in the meetings, and shall enjoy the privileges of such membership only upon signing the constitution.

Sec. 2. Persons non-resident in the cities of Minneapolis or St. Paul, but resident within the State of Minnesota, may be elected active members on the payment of an initiation fee of one dollar. Members non-resident in Minnesota are exempt from all dues.

Sec. 3. A life-membership shall be conferred on all members of the Minnesota Academy of Science who contribute the sum of one hundred dollars.

Sec. 4. The annual dues of the Academy shall be $3.00, except for non-resident members, whose dues shall be $1.00.

Sec. 5. Any member six months in arrears for dues shall become a suspended member, Provided, the Secretary shall have given two months 'notice by mail or otherwise; and such member shall remain suspended until all dues are paid.

Art. VIII. ORDER OF BUSINESS.

The Order of Business at the regular meetings of the Academy shall be as follows:

1. Reading the minutes of former meeting.
2. Communications.
3. Reports of committees and of chairmen of sections.
4. Miscellaneous business.

Art. IX. AMENDMENTS.

These By-Laws may be amended at any regular meeting of the Academy on one month's notice in writing. Such amendment must be unitedly proposed by three members.

LIST OF MEMBERS, DECEMBER, 1910.

Aiton, Geo. B., 1601 University Av., Minneapolis.
Allen, E. F., Minneapolis.
Andrews, Geo. C., University and 26th, S. E., Minneapolis.
Angle, Dr. E. H., St. Louis, Mo.
Appleby, Dean W. R., University of Minnesota, Minneapolis.
Arndt, Prof. E. L., 1280 St. Anthony Av., St. Paul.
Aurness, Dr. P. A., 420 Syndicate Arcade, Minneapolis.
Avery, L. B., Normal School, St. Cloud, Minneapolis.
Baker, Prof. H. S., St. Paul.
Ballard, C. A., Moorhead.
Bartleson, C. J., 712 N .Y. Life Bldg., Minneapolis.
Batchelder, Prof. L. H., Hamline University, Hamline.
Benner, Franklin, Minneapolis.
Bennett, R. M., Minneapolis.
Berkey, Dr. Chas. P., Columbia University, New York.
Bierbauer, Bruno, Mankato.
Bond, C. E., Minneapolis.
Bourns, Dr. Frank S., Manila, P. I.
Bradford, James E., Minneapolis.
Brown, Dr. E. J., 39 Syndicate Blk., Minneapolis.
Bryant, J. C., 1265 Laurel Ave., St. Paul.
Burchard, H. F., Minneapolis.
Butters, Dr. F. K., University of Minnesota, Minneapolis.
Butler, Nathan, 1619 7th St. S. E., Minneapolis.
Calhoun, J .F., 1611 Dupont Av. S., Minneapolis.
Calvin, Prof. S., Iowa City, Iowa.
Chaney, Prof. L. W., Carlton College, Northfield.
Channell, S. P., Minneapolis.
Child, S. R., 816 Lumber Exchange, Minneapolis.
Christianson, Prof. Peter, University of Minnesota, Minneapolis.
Clifford, Miss Julia B., East High School, Minneapolis.
Cook, John H., 906 N. Y. Life Building, Minneapolis.
Corbett, Dr. J. Frank, 2 Syndicate Blk., Minneapolis.
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INDEX

A.

Alpine Characteristics of the Flora of the Crest of the Coteau des Prairies, E. P. Sheldon, 11, 60.
American Association for the Advancement of Science, 333, 335, 340, 342, 344, 345.
Anorthosites of Minnesota. A. H. Elftman, 31.
Antennal Sense Organs of the Aphididaedele, O. W. Oestland, 219.
Ants, O. W. Oestland, 193, 227.
Apophyllite Geode, C. P. Berkley, 28.
Arndt, E. L., 268.
Ascoceras gibberosum, n. sp., 102.

B.

Baker, H. S., Relation of Fatigue to Progress, 192.
Beals, E. A., paper by, 191.
Beane, G. S., Elected Recording Secretary, 241, 246.
Bellerophon antiquatus White, 96.
Benner, Franklin, 320.
Berkey, C. P., Elected Corresponding Secretary, 190, 193, 195, 219, 227, 234, 241.
Berkey, C. P., Physographic Features of Franconia, 192, 200; Improved Method of Quantitative Determination of Antimony, Zinc, Iron, Copper and Lead, 210, 219; Origin of Copper in the Lake Superior Region, 220; Lecture on the Mining District of Cripple Creek, 221; Origin and Distribution of Minnesota Clays, 241; Elected Vice-President, 246; Points in the History of Microscopy, 17; Apophyllite Geode, 28; Datolite on the North Shore of Lake Superior, 42.
Birds of Minnesota, T. S. Roberts, 193, 406.
Bison (latifrons?), 420.
Bourns, •F. S., Letter from the Philippine Expedition, 138, 143, 156, 158, 166, 172.
Bourns, F. S., An Orang Hunt in Borneo, 173.
Boyle, David, Address, 327.
Brachiopoda, Evolutionary Development of, F. W. Sardeson, 31.
Bryan, Wm A., Lecture on the Philippine Bird Collection, 258.
Bryn Madelewr Marsh, Filling in, A. Jackson, 328.
Butler, Nathan, 320.
Butler, Eloise, Paper by, 345.
Butters, F. K., Paper by, 234

C.

Camp, F. A., Paper by, 267.
Cappelen, 195
Castoroides ohiaensis, 418.
Chaney, L. W., Paper by, 11, 45, 200.
Chairmen of the Sections, 42.
Channell, S. P., Presented Joplin sphalerite, 13.
Cheney, Wm. (and T. S. Outram), Meteorological Statistics, 123, 305.
Child, S. R., Elected a member, 323.
Cholera Epidemic in 1896, A. Schneider, 16.
Classification of the Sexual Affinities of Prunus Americana, C. W. Heidman, 190.
Classification of Insects, O. W. Oestland, 244.
Classification of the Metaphyta, C. MacMillan, 9.
Clifford, Julia B., Paper by, 327.
Cobalt—A New Locality in Minnesota, A. D. Meeds, 18.
Cook, Frederick A., Reception by the Academy, 343.
Copper, Its Origin in the Lake Superior District, C. P. Berkey, 220.
Crania reversa, n. sp., 77.
Countryman, Gratia, 320, 327.
Cypricardites frugosa, n. sp., 70.
Cypricardites desciptus, n. sp., 70.
Cypricardites finitimus, n. sp., 70.
Cypricardites dignus, n. sp., 70.
Cyrtoceras dresbachensis, n. sp., 102.
Cyrtoceras winonicum, n. sp., 102.

D.

Datolite in Northern Minnesota, C. P. Berkey, 42.
Deep Wells as a Source of Water for Minneapolis, N. H. Winchell, 266.
Development of the Minneapolis Sewer System, Andrew Rinker, 422.
Dikelocephalus minnesotensis On., 95.
Dunsmoor, Dr., Presented Vertebra of a Whale, 200.
Durant, E. W., 195.

E.

Eastern Limit of Glacial Lake Agassiz, U. S. Grant, 208.
Eddy, H. T., 213; Elected President, 227; Lecture on Attenuation and Distortion of Long-Distance Telephone and Power-Transmission Lines, Regarded as Dynamic Phenomena, 243.
Elephas primigenius, 415.
Elftman, A. H., Paper by, 208, 246, 251; Elected Vice-President, 257, 265; Paper by 265; Pewabic Quartzite, 28; Anorthosites of Minnesota, 31; Paper by, 41, 42, 45;

Resolutions as to Reduction of Postage Rates, 45.
Embryo—Sac of Angiosperms, C. MacMillan, 12.
Endoceras consultum, n. sp., 105.
Englacial and Superglacial Drift, Warren Upham, 343, 428.
Euomphalus winonensis, n. sp., 96.
Eustis, Henry W., Collection of Butterflies, 324, 326, 338.
Evening Grosbeak, T. S. Roberts, 406.
Exchanges, 2, 20, 184, 214, 319, 442.
Extinct Pheistocene Mammals of Minnesota, N. H. Winchell, 314.

F.

Fatigue—Its Relation of Social Progress, 192.
Fellows, C. S., Minute Aquatic Forms from the Philippine Collection, 15.
Foss, Elizabeth, Paper by, 345.
Franconia, Physiographic Features, Berkey, 194.
Frankforter, G. B., Lecture by, 235.
Franzen, J. W., New Curator, 339, 341, 342, 343, 345.
Future Timber Supply, T. B. Walker, 340; 347.

G.

Gale, E. C., Elected Treasurer, 8 26, 190 195, 213, 219, 227, 234, 241, 246, 257, 265; Impressions of the Panama Canal, 342.
Gale, Harlow, Elected Member, 193; Paper by, 228, 259; Elected Recording Secretary, 257, 265, 268; Resolution on the death of Dr. A. E. Johnson, 322; History of Mind Cures, 331; Psychology of Music, 341; Paper by, 346; Historical Sketch of the Academy, 430.
Glacial Lakes St. Louis and Nemadji, N. H. Winchell, 208.
Goode, J. P., Paper by, 42.
Grant, U. S., Stratigraphical Position of the Ogishke Conglomerate, 13; Notes on Some Water Divides in Northwestern Minnesota, 39; Paper by, 44; Eastern Limit of Glacial Lake Agassiz, 208; Rainy Lake Gold Region, 210; Minnesota Lakes Having More than One Outlet, 212.
Guthrie, J. E., Paper by, 220.

H.

Hafer, Claude, Elected Member, 202; Paper by, 220.
Hall, C. W., Recording Secretary, 8, 26, 190; Artesian Basins, 194 201; 202; 210; 228; Elected President, 234, 241, 265; Paper by, 260, 335; Structure and Lithology of the Magnesian Series, 18, 119; Lecture on Formation and Deformation of Minnesota Lakes, 29; Need of Weather Records, 40; Paper by, 339.
Halley's Comet, F. P. Leavenworth, 346.
Heidman, Sexual Affinities of Prunus Americana, 190.
Helicotoma peccatonica, n. sp., 97.
Hennepin at the Falls of St. Anthony, N. H. Winchell, 339, 380.
Hewitt, C. N., Lecture on Cholera and Common Sense, 27; Paper by, 46; Good Water, 194.
Hisingerite in Northern Minnesota, H. V. Winchell, 42.
Historical Sketch of the Minnesota Academy of Science, H. Gale, 430.
Holopea of obliqua Hall, 74.
Holopea paludiniformis, Hall, 75.
Holopea obesa Whit, 97.
Hovland, H. B., 193.
Housten, 195.

I.

Influence of Anaesthetics on Plant Transpiration, A. Schneider, 10.
Ives, Frank, Elected Member, 211.

J.

Jackson, A., The Bryn Mawr Marsh, 328.
Johnson, Dr. A. E., Resolutions on His Death, 322.

L.

Laciniaria of Minnesota, E. P. Sheldon, 55.
Lange D. J.., Influence of Mammalian Life on Trees, 334; Birds and and Animals of Northern Minnesota, 338.
Leavenworth, F. P., Paper by, 346.
Lectures of a More Popular Character Provided for, 19.
Leonard, W. H., Memorial Tribute, 332.
Letters from the Menage Scientific Expedition, 138, 148, 156, 158, 166, 172.
Library, Relations to the Library Board, 336.
Library Board, 336, 337, 344.
Lincoln Schools of Science, Resolution by Winchell, 340.
Lingula morsii, Winchell, 78.
Lingula mosia, Hall, 95.
Lingula aurora, Hall, 95.
Lingula dolata, n. sp., 95.
Lingula winona, Hall, 96.
Lowry, Thomas, Memorial Tribute, 340.
Lyon, Dr. H. L., Review of Hayward's Burbank's "New Creations in Plant Life," 324.

M.

MacDougal, D. T., Elected President, 219.
Mackenzie, John, Structure of the Universe, 345, 385.
MacMillan, Prof. C., Current Methods of Botanical Instruction, 9; Paper by, 44, 191; Classification of the Metaphyta, 9; Embryo-Sac of Angiosperms, 12; Elected Vice-President, 26.
Magnesian Series, The Fauna of, F. W. Sardeson, 92.
Mammoth in Minnesota, N. H. Winchell, 333.
May, Fred M., Paper by, 266.

McCurdy, C. W., Poisonous Plants About Winona, 11.
McGinnis, R. G., Paper by, 191.
Mechanics of Heredity, C. MacMillan, 27.
Meeds, A. D., Excursion Into Northern Mexico, 14; New Locality of Cobalt, 18; Elected Recording Secretary, 195, 207.
Menage Scientific Expedition to the Philippine Islands, 31, 131.
Mendenhall, R. J., Memorial of His Death, 328.
Meteorological Statistics, Cheney & Outram, 123, 305.
Metroptoma baraburensis Whit, 97.
Microscopic Study of Plant Lice, O. W. Oestland, 17.
Microscopy — Points in Its History, C. P. Berkey, 17.
Mineral Resembling Meerschaum from Hampden Co., Mass., A. D. Roe, 268.
Minnesota Lakes Having More than One Outlet, U. S. Grant, 212.
Mitchell, E. C., President of the St. Paul Academy, 191.
Moyer, L. R., Prairie Flora, 339; Prairie Legumes, 346.
Murchisonia gracilis, Hall, 75.
Murchisonia of tricarinata, Hall, 75.
Murchisonia argylensis, n. sp., 97.
Murchisonia putilla, n. sp., 98.
Museum of the Academy, 29, 259, 342.

N.

Nachtrieb, H. F., Elected President, 8; New Species of Lemuroides, 9; Phagocytes and Disease, 11; Paper by, 44.
Nordenskjöld, Dr. Otto, Reception for, 322.
Norton, H. B., Studies of the Drift, 323, 345; Causes of Earthquakes, 327; Symposium on Water Supply—

O.

Oestlund, O. W., Microscopic Study of Plant Lice, 17; Ants, 193, 227; Elected Vice-President, 219, 227, 234, 241; Antennal Sense Organs of the Aphididae, 219; Classification of Insects (Abstract) 244; Elected Corresponding Secretary, 246, 257, 265; Paper by, 258, 259; Walking Stick, 325; The Library, 330.
Ogishke Conglomerate, U. S. Grant, 13.
Ophileta alturensis, n. sp., 98.
Ophileta fausta, n. sp., 75.
Orang Hunt in Borneo, F. S. Bourns, 173.
Orthis perveta, Con., 78.
Orthis pepina, Hall, 96.
Orthoceras, minnesotense, n. sp., 77.
Osborn, H. E., Weather Forecasting, 332.
Osborn, H. L., Paper by, 9, 27; Lecture on Structure and Habits of Rodents, 27; Dipolomys ordii, 31; Rodentia in Evolution, 46; Elected President, 26, 37, 190; Paper by, 242; Linné Anniversary, 333.
Ovibos cavifrons, 418.

P.

Panama Canal, E. C. Gale, 342.
Parsons, A. L., Paper by, 258; Morphological Characters of a Mineral from Hampden County, Mass., 272.
Pewabic Quartzite, A. H. Elftman, 28.
Phagocytes and Disease, H. F. Nachtrieb, 11.
Philippine Island Collections, 9, 15, 29, 13, 220, 221, 259.
Piloceras corniculum, n. sp., 103.
Platyceras vetulam, n. sp., 76.
Pleurotomaria aiens, n. sp., 76.
Pleurotomaria sweeti Whit, 99.
Poisonous Plants About Winona, C. W. McCurdy, 11.
Porocrinus Zone About Minneapolis, F. W. Sardeson, 267.
Postage Rates, Proposed Reduction, A. H. Elftman, 45.
Pratt, W. H., Elected Corresponding Secretary, 8, 26; Obituary Sketch, 37.
Prairie Flora of Western Minnesota, L. R. Moyer, 338, 357.
Prairie legumes, L. R. Moyer, 346, 373.
Prehistoric aborigines, N. H. Winchell, 378.
Proceedings of the Academy, 1, 183, 319.
Psychology of the Business Man, Harlow Gale, 281; of Music, 342.

R.

Rainfall and Evaporation, Warren Upham and C. W. Hall, 40.
Rainy Lake Gold Region, U. S. Grant, 210.
Random, Gilbert, Theories of Gravitation, 331.
Rate of Propagation of Smell, John Zeleny, 257.
Raphistoma leisomellum, n. sp., 99.
Raphistoma lewistonense, n. sp., 99.
Raphistoma minnesotense On., 100.
Raphistoma owenidele, n. sp., 100.
Raphistoma ruidum, n. sp., 101.
Raufella fucoida, n. sp., 78.
Reed, Edgar, Elected a Member, 323.
Revised Constitution and By-Laws, 452.
Rinker, Andrew, Sewer System of Minneapolis, 325, 422.
Roberts, T. S., Elected Vice-President, 8; Elected President, 195; Birds of Minnesota, 193, 331, 342, 406.
Rodentia in Evolution, H. L. Osborn, 46.
Roe, A. D., Elected Recording Secretary, 219; Paper by, 220; Elected Curator, 221; Mineral Resembling Meerschaum, 268; Proposed Amendment to the Constitution(323; Restoration of the Museum, 326; Memorial Tribute, 337.
Rum River Valley as a Botanical District, E. P. Sheldon, 88.
Rundlett, 195.

S.

Saint Peter Sandstone, F. W. Sardeson, 64.

Sardeson, F. W., Water Supply of St. Paul, 30; Evolutionary Development of Brachiopoda, 31; Paper by, 45; St. Peter Sandstone, 64; Fauna of the Magnesian Series, 92; 200, 213; Terrace Gravels about St. Anthony Falls, 219; Glacial Plowing at Minneapolis, 228; Paper by, 227, 260; Lectures by, 242; Discovery of Tetradium, 259; Porocrinus Zone at Minneapolis, 267, 324.

Schneider, Albert, Influence of Anaesthetics on Plant Transpiration, 10; Outlook for Cholera Epidemic in 1903, 16, 29.

Sheldon, E. P., Characteristics of the Flora of the Crest of the Coteau des Prairies, 11, 60; Lacinlaria of Minnesota, 55; Rum River Valley as a Botanical District, 88.

Smith, H. W., 194.

Some Features in the Geology of Northeast Minnesota, N. H. Winchell.

Spurr, J. E., Paper by, 44.

State Academy Proposed, 201, 209, 251.

St. Paul Academy of Science, Joint Meeting With, 191, 193.

Straparollus intralobatus, n. sp., 101.

Structure, Lithology and Genesis of the Magnesian Series of the Northwest, C. W. Hall, 119.

Structure of the Universe, Reynolds' Theory, John Mackenzie, 345, 385.

Subsulites exactus, n. sp., 101.

Sudduth, W. X., Paper by, 30; Vice-President, 190.

T.

Tellinomya novicia, n. sp., 74.

Tellinomya absimilis, n. sp., 74.

Truesdell, Verdine, Elected Trustee, 190; Death, 201, 207.

Trybiidium repertum, n. sp., 102.

U.

Upham, Warren, Rainfall and Evaporation, 40; Paper by, 41, 234; Explorations of Verendrye, 277; Glacial and Modified Drift of the Mississippi Valley, 299, 324; Discovery of the Mississippi River, 335; Englacial and Superglacial Drift, 343, 428.

W.

Walker, T. B., Elected President, 246, 321, 330, 336, 341, 344; Early Interest in the Academy, 320; Future Timber Supply, 340.

Warville, F. G., Elected Recording Secretary, 227, 234.

Water Divides in Northeastern Minnesota, U. S. Grant, 39.

Water Supply, 266, 339, 340.

Willamette Meteorite, N. H. Winchell, 267.

Winchell, H. V., Locality of Cobalt and Nickel in Minnesota, 18; Hisingerite, in Northern Minnesota, 42; Remarks on a Pseudometeorite, 42; Origin of Ore Deposits, 337; and the Menage Expedition.

Winchell, N. H., Some New Features in the Geology of Northeastern Minnesota, 201; Glacial Lakes, St. Louis and Nemadji, 208; Elected President, 207, 218; Paper by, 251; Deep Wells as a Source of Water Supply for Minneapolis (Abstract), 266; Willamette Meteorite, 267; 321; Aborgines of Minnesota, 332, 378; Mammoth in Minnesota, 333; A Supposed Meteoric Stone, 334; Hennepin at the Falls of St. Anthony, 333; Lincoln Schools of Science, 340; Extinct Pleistocene Mammals of Minnesota, 415.

Worcester, Dean C., Lecture by, 43; Letter from, 9, 26, 27, 138, 143, 145, 150, 161, 163, 169, 170, 209.

Wulling, F. J., Elected a Member 323; Elected Vice-Pdesident.

Zeleny, John, Rate of Propogation of smell, 257.

5132

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ANCIENT GLASS AND POTTERY.

President T. B. Walker.

Excepting perhaps decorative carvings on bone and on shell ornaments for personal adornment, the most ancient of all arts is that of making and decorating pottery or earthenware. The art of the potter has been the predominant one in all the early ages and from its universal distribution and as useful and ornamental art, it may be regarded as the primary and foremost art of the world, both ancient and modern.

The potter's art led to designing, coloring and illustrating. It was the forerunner of sculpture, decorative architecture and of the art of painting. And while the sculptor's and painter's art appeals more to the interest and art tastes of mankind of the later ages, yet the more generally applied art of the potter and glass maker has extended more universally through all the domestic and art life of the world. It represents such a vast variety of beautiful forms and colors, as well as decoration for universal use, that from the standpoint of its useful application and varied forms, the potter's art, and particularly if we add that of glass, will stand, foremost and generally the most valuable and attractive art of the world, taking precedence over painting and sculpture.

The art of glass-making has commonly been regarded as a much more modern discovery or invention than written history and more particularly the records of the tombs and old ruins indicate. While glass for common use as windows for admitting light but excluding wind and rain is more a modern innovation, yet the making of glass, particularly of the much finer and more beautiful examples, dates back to earlier times. In the ruins of old Bablyonia are found examples of finely colored glass that are so hard that it requires the use of carborundum to cut and polish them. The discoveries are mostly of small pieces, evidently made of pulverized gem stones made into glass either by entire fusion or by the mixture of the ground material with an otherwise clear glass compound that makes of it a clear but beautifully colored glass, that has all the appearance of the gem stones being melted, and very similar to the modern scientific ruby and saphire. Some of it apparently is pulverized bort or diamond dust, freed from impurities so as to leave the glass clear or translucent. These earliest specimens are found in the ruins of the old temples and palaces and are only the smaller and more valuable and harder specimens that have withstood the action of the alkalies of the earth for forty centuries for the oldest specimens. Those that were made of less permanent materials have not been able to withstand the corrosive influences of time for so many centuries.

The next and most important examples of ancient glass, running back to perhaps one or two thousand years before Christ, is the inlaid glass of the Egyptians, as found mostly in the old tombs, but occasionally in the old ruins. These seem to be not quite so hard, but still heavy and solid and harder than modern glass, but all are made of inlaid or banded glass that later times have never succeeded in reproducing. These pieces are mostly in the form of what were evidently highly priced ornamental pieces used more in the manner of the larger gem pieces. The glass is of variegated colors representing mixtures of different kinds of gems and fine stones seemingly rubies, saphires, emeralds, topaz, garnets, amethysts, beryls and perhaps including also jade, onyx, chalcedony, and other finely colored stones. These were evidently pulverized, the impurities taken out, and in some way made into a hard translucent glass that by some peculiar method, that the moderns have not been able to discover, was made into the beautiful variety of variegated colored glass found in the tombs of these ancient people, in the form of bottles, vases, etc. They generally range in length from three to five inches and were evidently used as scent bottles carried as ornaments.

The tombs of Egypt do not contain the lighter variety or clearer examples of glass bottles and vases found in the later Syrian tombs. Whether or not the extra one or two thousand years of time might have entirely decomposed them, as it has in large part those in the Syrian tombs, in a shorter period of time, has not been determined. Ranging from a little earlier than the Christian era the old Syrian tombs of six or eight thousand years previous to that time were provided with large numbers of very beautifully shaped ornamental and finely colored glass made of something like the same mixtures of the more ancient, but of a much less permanent and a softer material. These consisted mostly of colored bottles which were placed in the tombs with the bodies of the dead for use by the spirits of the women in beautifying their faces and evidently supplied with water and wine, and ,the nursing bottles with liquid food for the children. They are very artistically designed, rather more so than the later art of the glass-maker and their lying for two thousand years or more in the dust of the disintegrated roofs of the tombs has made them beautifully irridescent. When collections of the finest pieces are brought together they present one of the finest and most beautiful displays, in many respects similar in beauty and attractiveness to the collections of inlaid glass pieces found in the old Egyptian and Babylonian tombs ,and coming next in making a beautiful display to a collection of the finest ornamental gems, only these are on a larger scale and of greater variety of form and color.

The Phoenicians of about the time of Christ began the manufacture of glass which they perhaps learned from the Greeks or Syrians, and they made a glass somewhat different and harder and somewhat more of an approach to the inlaid glass of the ancient Egyptians. Many of these pieces are found in the later tombs of Syria, made after this glass had come into use. The Greeks also were glass makers, but were given more to the manufacture of pottery and to modelling in clay and sculpture of marble. The Romans in the second or third century before Christ developed the highest and most refined and beautiful art glass that has been known at any time excepting as to their not being able to produce as fine a variety of inlaid glass, although their murrhine glass was variegated and to some extent inlaid and made of finer gems and produced far more valuable or at least higher priced glass vases than have been known before or since. During and just previous to the time of Nero, the greatest extravagance existed in the value put upon murrhine or gem glass. History records that Petronius gave three thousand talents for one cup or vase made of gems, which before his death, in order to keep it from falling into the hands of Nero, who it was claimed was waiting for Petronius to die, in order that he might confiscate his great collection of fine glass pieces, he destroyed, and the fragments of this magnificent vase together with all of Petronius' collection Nero exhibited in the palace gardens and invited multitudes of people to view them. It is said that Nero afterwards paid three thousand talents for a piece of gem glass smaller than the piece destroyed by Petronius. The smallest value of a talent is a little over one thousand dollars of American money, which would make the price paid for these vases over three million dollars. This is condemned by Pliny, the historian, as a piece of reckless extravagance on the part of the ruler of the world. This fine glass of the Romans was evidently made of pulverized gems the same as the glass of the ancients, but no pieces quite so hard as those of Babylonia have been found, although deeper and finer colors and more variegated and gem-like pieces were evidently made and some of them have been preserved in the tombs or ruins down to the present time.

The Venetians took up glassmaking in early times and produced great varieties of magnificently colored forms and beautiful shapes that when the finer pieces are brought into a collection, make about as fine a display of artistic form and color as can be found in the world. All of the nations since have to a gr eater or less extent preserved the art of glass-making, and have carried it out in such beautiful colors and forms for domestic use that it has led to the general feeling that the glass-maker's art is designed more to supply the household with useful articles, in the same manner that the potter's art has come to be so customarily seen in everyday use that the beauties and appreciation of both glass and pottery are underestimated.

The interest and attractiveness of the art galleries of painting and sculpture appeal more generally to the taste and satisfaction of the person than the collections of pottery and glass. But of the latter, a greater quantity with the highest and finest and most beautiful forms and colors found in the productions of the potter's and glass maker's art made for the finest decoration, appeals more and more to the interest and art taste in proportion, generally, as the individual becomes acquainted with and studies out their beauties and perfections in form, color and finish. The earthenware being so commonly in use, comes to be looked upon more as a common household utility than a fine decorative art. But experience shows that to the extent that the person will become acquainted with the refined and beautiful potter's and glass maker's art does the interest increase and may become a source of more satisfaction than would come from the painter's and sculptor's work.

The potter's art flourished in proportion to the degree of civilization or advancement of the ancient nations and tribes. The potter and the stone implement maker represent the primary art industries that began or preceded the civilization of ancient times. Its origin was more a matter of utility and convenience than one of artistic expression. But from the very beginning, the idea of ornamentation or beauty of form or color or artistic delineation of figures, flowers or other designs entered into the potter's art.

Away back in early ages, next in time to the inscriptions and designs made on the bones of animals found in caves and gravel beds, is found the earthenware of the pre-historic people. The flint implements while they might be classed with useful art, were not made for ornamentation, but for use in the chase and in war. This, with earthenware, antedated all others that can in any manner be classed as art. They were to a large extent contemporary.

In many of the old mounds of the uncivilized tribes of the world, vessels of pottery including many of quite artistic designs are found. Among the civilized nations, the potter's art runs back to a period traceable to twenty-five hundred years B. C., in the ruins of the cities of the old Babylonian empire, and in Egypt, to a date more than three thousand years B. C. In the old Egyptian tombs is found glazed pottery made as early as 3800 years B. C.

The old Babylonian clay tablets are probably many ages later than the oldest earthenware vessels made for domestic use and burial service. On these were inscribed the records of the temples in the ruins of which the tablets were found. The oldest of the tablets which I have obtained were secured from the ruins of Nippur or of Tells, which two names may mean the same old city, or of a little different ruins of about the same date, probably the very same. This ruin was situated about 75 miles south of Babylon on the west side of the Euphrates and seems to have been older than the city of Babylon. The tablets came from an old stone vault that seems to have preserved them from destruction or serious damage. They are made of a very hard, compact clay, quite solid and strong and have withstood the wear and tear of the ages, as they were probably submerged in the mud of the river. Some of them are so decomposed on the surface that they are not readable. The one here shown was made in the reign of the Priest-King Dungi or Ur about 2500 B. C. and is translated as follows:

1. Half a gur and 2 kas (ephaha) of food.
2. the property of Kul-bar.
3. four kas of wine, 1 kas of food.
4. the property of the palace.
5. 5 kas of milk, 3 kas of food.
6. 2 barrels of oil, 2 great barrels of oil.
7. (signed or furnished by) Sin-Tur-Lik.
8. the steward, the son of————

These tablets date back to different periods up to 500 years B. C. in the old Babylonian ruins. But most of them not having been protected against the action of the elements, where they were fully exposed in the dirt and gravel, have become weathered until there are only small remnants left and probably great quantities have been entirely destroyed. Back in the same ages and in the same country and ruins are found pieces of ancient glass,—cups, vases, and lamps, or remnants or pieces of them, more numerous than full complete specimens. It is claimed that many of these specimens were made from pulverized gems or minerals,—diamonds, emeralds, rubies, garnets, topazes, amethysts, jades and other fine stones pulverized and made into glass, some of which are exceedingly hard and many pieces of exceedingly fine and beautiful color, almost as fine as the gems themselves. (Mr. Walker exhibited a small bottle made of pulverized gems).

Of the old eighth century Persian or Babylonian pottery, a most beautiful and exceptional collection has been gathered from the old tomb and the old palace of Haroun Al Raschid who is considered the most celebrated of the eastern califs and the most powerful sovereign of the dynasty of Abbassides. He is chiefly renowned as the hero of the "Arabian Nights" entertainment; was born in 776 and died in 809. The tomb at Bagdad in which his wife was buried, was completed about 795 and the palace some years earlier. In this tomb he placed a very great number of the finest of the pottery vases that the potter's art of those times could produce.

Several years ago, the present consul of Persia to this country succeeded in getting a concession or permit to explore this tomb and take out the pottery. Through the agency of his brother who represents him here in New York when he is back home, I succeeded in getting a great portion of all the stoneware vases that were taken out of the old tomb. And from the same parties and others, I secured many beautiful pieces from the ruins of the old palace of this same ruler who built the great tomb. Some of them are marvelously well preserved from the fortunate protection which they received in the ruins. (Pieces were shown).

The examples from the old tomb, which is said to have been one of the finest and largest in the world, were so well protected from the elements that the pieces were nearly all preserved intact, and damaged or injured only by the contents which were placed in them to provide food, water and wine for the spirits of those buried within the tomb and such others as might be admitted or called in with those whose bodies rested there. Some of them are colored quite dark brown, presumed to have been caused by the oil that was placed in them. Others for different kinds of food were stained to different degrees; in fact, some very fine pieces were so much discolored and injured from the inside that they were practically ruined. The glaze was very thick on the outside but the stain came through the cracks and more porous part of the inside which stained the underside of the glaze, and the glaze being translucent, showed the amount of discoloring which in some cases was not sufficient to damage but gave a deeper, richer color; but in other cases injured or almost ruined them for examples of fine coloring. The form and color of these will be found peculiar to those people and very different from the art of the surrounding nations or of the Chinese, Japanese, or Koreans.

As Babylonia did not contain a great number of tombs, the potter's art of this country of early times has in large part disappeared, even up to a point of time much later than the building of this tomb and palace, as most of the pottery found now in the museums came from the 13th, 14th, 15th and later centuries.

That which comes next and would take precedence in time really is that of the old Egyptian empire. Whether the potter's art in development with this people antedated the old Babylonians, is not certain. There is certainly greater opportunity for gaining a knowledge of the early art in Egypt than in Babylonia, and especially of that which pertained to religion or burial services.

In the Egyptian tombs have been found many heavily glazed pottery images called ashebties. These probably comprise the oldest glazed pottery among the ancient nations. This pottery ware has the ancient hieroglyphic symbols, which bear the dates of the dynasties under which the burials were made, running back to the remote ages as far as three thousand years or more B. C.

These ashebties were buried sometimes in considerable numbers with each mummy, as all those who were of sufficient importance in the world to go into a tomb were supposed to be people of some fortune; these ashebties were placed with the bodies of the men in proportion to their presumed standing or wealth while living, or to represent their estates after death. These little images were supposed to be able to look after the welfare of their principal, and prevent his spirit from being annoyed and troubled, and to pay his way or work out his taxes or affairs in the other world. There were buried with the bodies of the priests a peculiar ashebtie called the "Recorder" whose mission was supposedly to look after the various personal interests, either spiritual or temporal, and to see that the taxes were paid and religious rites were attended to. These small figures were formed of potteryware and were heavily glazed in many cases with the strongest blues and, in others, with lighter blue and occasionally with grey colors, but mostly in the blues of different shades. Some of these, after lying two or three thousand years in the tombs, look as though they were of recent origin, excepting when more carefully examined. They have on them the hieroglyphic or written language of the ancient Egyptians which gives the dates, names, etc., the dates being only the name or the seal of the dynasty under which the images were made, the same as in the old Chinese records.

There was also buried with each body, not only of the men, but of the women also, what is called a scarab. This is the ancient emblem of the origin and continuance of life. The scarab, or tumble bug, whose history dates back to the earliest ages, not only of the Egyptians, but also of other nations, although not as emphatically as among the Egyptians, was looked upon as a most absolutely essential protection against annihilation. They believed that the individual should be protected during his life here by wearing or carrying one or more, or many, scarabs, but it was more necessary to have one or more placed in their tombs after death. Some of them are made of valuable gems and others of quite fine stones, as: agate, chalcedony, cachalong, lapis lazuli, obsidian, garnet, beryl, jade, quartz, zircon, topaz, spinel, chrysoberyl, turquoise, opal, nephrite, malachite, onyx, amethyst, jasper, and besides many are made of different kinds of potteryware and glaze.

The scarab had frequently the name of the owner as a seal, and sometimes the date, the latter given through the name of the ruler of the times which was the method in ancient Egypt and China of giving the dates. I have one quite large scarab seal made of turquoise and a seal made of pottery in imitation of turquoise that were found in an old Egyptian tomb with the body of one of Pharaoh's generals who died during his reign. The scarab, which is also a seal on the bottom, has the image of Pharaoh in the center and on each side is the signature or hieroglyphic name of this Pharoah or Amen Hotep II., or Menophtes, of the date of about 1725 B. C. The inscription on this is traceable historically to this ruler and the ancient history of the tombs records this as being the scarab of that date and of that ruler, the seal being the personal seal of one of the important personages of that era, and not only attributed to but assigned to one of Pharaoh's generals.

These scarabs were used not only as sacred charms but were used for seals with the inscriptions cut on the under side. Many of the very important ones were made of their finest pottery or glaze, which glaze was more in the nature of a very hard permanent enamel. There have been but few if any ancient Egyptian tombs opened that did not have considerable numbers of these imitation sacred bugs. An Egyptian who would know that he was to be buried without the scarab would be filled with terror.

In these tombs are also found inlaid glass made into bottles or amphoræ of fine forms and colors. Just how they succeeded in producing this inlaid work with its many straight or zigzag glass bands of variegated colors found only in this ancient form, is not known to the modern glassmaker. This glass seems to be only about the specific gravity and hardness of modern glass. (Pieces were shown).

Following next appropriately would come the glass of the Syrian tombs. There were more tombs discovered in Syria than in perhaps all the rest of the world. One explorer has opened over 8,000 of these tombs or sepulchres in the rocks, mostly in Syria proper. The date of these is in large part from the time of Christ back about 500 years, but some of them earlier. From Christ's time back two or three hundred years will cover a considerable large part of the glass objects found so abundantly in them. Among these are many varieties of glass bottles and pitchers, nursing bottles, and very abundantly the ungentariums, or color bottles, for use by the spirits of the women with whose bodies they were buried. There was generally but one of these with each, containing mostly the two colors of paint; the black to color a circle around the eye and the red to color the cheeks. In some cases, there were four divisions. In two of them were two different shades of red, in the other two a black and a white, but this was the exception not the rule. Some of them had but one color. With them all were bronze rods that were used to apply the color. Very many of these old ungentariums have become so corroded by time that they have been wholly or largely decomposed and most of them have been, to a considerable extent, so scaled away by the centuries that they have lain in the dust of the tombs, that they are beautifully iridescent, while coating after coating of a thin film of pearly scales like different layers of thin glaze have been formed and one after another peeled off and, for those that are left perfect, a most beautiful surface has been formed. (Specimens were shown).

The most beautiful of the glass found in the Syrian countries is that made by the Phoenicians who have been credited, generally, with being the earliest glass makers; but it is quite certain that the Babylonians made glassware at a much earlier time so far as the samples show. But in both nations the finest and most beautifully colored pieces were made by mixtures of pulverized gem chips and pieces that gave the fine color and in some cases the weight and hardness. (Samples were shown).

The ancient Greek art, like that of all other nations, began with pottery. But the art of glass-making in Greece proper was not known or practiced to the extent found in Syria. Their pottery was mostly of common clay, and a glaze with something like an asphaltic paint, which stood the firing and made generally a black or brown, and sometimes other colors.

Their ornamentation or drawing and designing showed a much greater art skill than those of any other nation. Many of the finest and most beautiful of their vases were made from two to six hundred years before Christ and left in the many tombs found in Greece. They were placed in the tombs in the same way as in the tombs of most of the other nations, evidently with a supply of food and drink, either water, wine or oil and food in the way of rice or wheat or sometimes perhaps with fruits or nuts. The case of Grecian vases in our museum represents nearly all of the finest selected pieces from the collection of Mr. DeMorgan who spent many years as explorer for the museums of France and of this country, and particularly for the Brooklyn museum. He explored mostly in Greece where he gathered a magnificent collection from outside of his personal explorations, such as he could secure without interfering with the interests of the museums which he represented. The collection was sold in New York and these, with the exception of two or three very large ones, were secured from that sale.

In the same tombs were found in very large numbers, these in the average being mostly one or two, sometimes more, with each body, either men or women, beautiful pottery figures called the Tanagra figures. They were made of a peculiar clay that would dry without cracking. They were made hollow and a square hole left in the back of the image by means of which it could be hung onto a peg in the stone wall of the tomb in which the body was placed. These are perhaps the most artistic and beautiful figures that any ancient or modern nation has produced. There were no two of them alike. For many years—perhaps several centuries—there were many artists who devoted their time to reproducing these beautiful figures, such as those shown here. (Mr. Walker gave an account of imitations that were sold at high prices).

This earlier Greek art of the potter led into and developed the higher and more important sculptures and architectural designs and carvings of the great art period of the Greeks.

In earliest times only sun-baked or fired, unglazed earthen or clay vessels were made. Later, better forms and glazing marked the next step of advancement.

First came the sun-dried vessels, bricks or tiles; next, the unglazed wares, fired in ovens and kilns; then the glazed earthenware, mostly fired in higher temperatures; then the stone wares, harder, whiter, denser, somewhat vitreous; next, porcelains made under highest temperatures, vitreous, translucent, made of quartz and kaolin, and the soft paste porcelains made of kaolin without quartz, but sometimes with other softer materials.

In China there was well glazed, single colored earthenware of good form, coloring and finish during the Hesia, Shang, and Chou dynasties. These periods date back from 2205 to 205 B. C. There are very few, if any, certainly authenticated examples of this old ware, excepting some pieces or fragments that evidently run back perhaps through this period, showing only common earthenware, but nothing that appears to be as far advanced as stoneware; nor was there any ornamentation other than the color that was in the glaze. During the latter part of these reigns there has been claimed by Chinese historians to have been something like porcelain or stoneware, which among the earlier Chinese were classed together, not making sufficient distinction between the opaque and the translucent.

In the Han period which covers what is known as the Han and the eastern Han reign from 201 B. C. to 220 A. D., there have been found a considerable number of good examples that were authenticated as belonging to this period. It was a time when there were seemingly more religious rites, and more ancient tombs, temples and sepulchres, and in these there were found quite a considerable number of interesting examples, particularly in a series of ancient tombs that were swept away by a great flood in the Yellow river a few years ago.

There are two examples here, one of which is regarded as the finest and most characteristic piece that has been found. (Pieces were shown).

I have found no fine examples coming between this Han period and the Sung dynasty—420 to 479 A. D.

The example from this Sung period comes from a priestly temple and tomb. It is a taller piece and quite extensively ornamented with symbolic figures of men and animals, supposed to be sacred priests with the dragon, and various other symbols representative of religious ideas of the times. It is of a more common variety of earthenware with only a common, plain gray glaze, but highly prized by collectors.

The next period of which I have satisfactory examples is the Tang period 620 to 907. It shows but little advance between the end of the Sung—479, to the end of the Tang—907. In this example the form is somewhat finer and more artistic but the earthenware is about the same. The northern Sung period began 960 and ended 1127, the example shows a continuance of the same general one-color glaze, but in this piece a mottled blue and brown. A quite beautiful and smooth vase of a little higher grade approximating to stoneware originated the advance during or prior to this period.

But up to the time of the eighth century there does not appear to be anything that equals that of the Persians as shown by the examples found in this old tomb of Haroun Al Raschid and in the ruins of the castles and palaces in the old remains of cities round about, called Racca ware. It would seem from this that the Persian potter had made advances in this art beyond that of the Chinese up to about the 12th or 13th century when stoneware and porcelains were being made by the Chinese.

The broken records of the two nations show that the Persian potter was in the lead up to about the thirteenth or fourteenth century of our era when the Chinese took the lead and the Persians' art seems to have declined. The Chinese pottery changed from earthenware or a somewhat harder stoneware to much higher grades of earthenware in the Ming dynasty. Whatever particular advancement was made prior to that time in higher grades of pottery or porcelains is not clearly known or shown, as there has been so incomplete a record prior to the Ming dynasty.

Of the Yuan dynasty 1279 to 1358, there are two examples here showing very clearly a finer grade of pottery approximating to porcelain, even better than stoneware. Both of them are similar to the prevailing wares of the great Ming dynasty of which this period seems to have been the forerunner.

Of the Ming there are two fine examples, similar in general form to the two of the Yuan dynasty just above referred to.

During the Ming period (1368-1644) came a great advance bringing out finer wares of all the earthenwares, stoneware, and porcelains. It was somewhere near the beginning of this long period that porcelains were made. In the latter part of this period, some of the finest of the Lang Yao wares of peach-pink or ruby-reds were produced. The color and forms reached from the strongest and most positive to the softest colors and most delicate forms.

The period of production of finest and most attractive and most valued porcelains is that of the Kong Hse period from 1661 to 1723. While there are many fine pieces greatly admired and that bring high prices, made during the Ming period, yet there are greater numbers from the Kong Hse period,—more aggregate value from them than all the others together; some pieces bringing in the sale of noted collections from five to forty thousand dollars each.

Mr. Morgan has some pieces which come with a quite large collection for which he paid $785,000 for the collection, that could not have been purchased separately for $50,000 each. In England the finest porcelains bring the largest prices. Blue and white ginger jars, Lang Yao vases and larger beakers of fine colors bring from $20,000 to $40,000 for the very finest pieces.

The next most highly priced porcelains were made in the Kien Lung period from 1736 to 1796. The Chinese collectors and dealers regard this as an art period equal to or greater than the Kong Hse. But the wares do not bring as high prices in Europe and America, although they are increasing in value and may in future years bring about as high prices.

The more modern periods since 1796 have not produced wares that bring very high prices, although many fine pieces and reproductions are made.

Art glass does not seem to have been much known in China, or greatly valued until the Kien Lung period which began in 1736. During this reign there were many finely colored, solid, many-colored glass, cylindrical bottle-shaped pieces made that were quite highly valued. They were said to have been made by pulverizing fine minerals like jade, chalcedony, topaz, garnet, amethyst, etc. This is discredited by some, but claimed to be correct by others.

The old Korean pottery dates back to an early date, but probably not as early as in China. But the lack of any complete record or history of the potter's art in this less known kingdom in all probability gives less value to the work of their potters than the real facts, if known, would indicate. (Examples).

The Japanese learned their more advanced potter's art from China and Korea. Korean potters established themselves in Japan the first and third centuries of our era, others came in the fifth and seventh centuries, and still others were brought over to Japan in about 1530. This Ming Chinese period really marked the beginning of Japanese art, while that of Korea declined until it became almost extinct as an important art industry.

The stonewares or earthenwares of the old Roman potters of about the Christian era, as found in the ruins of Herculaneum and other ancient cities, are most peculiar in form and color and different in general designs from that of any of the other nations, ancient or modern. The large number of of examples that are in, or yet to be placed in, the museum, are the only reproductions of any of the pottery in the collections. Originals are not obtainable excepting rarely a rather unsatisfactory example.

Most museum examples are reproductions, the same as in other ancient art of pottery, bronze, and marble where originals are not obtainable, and great numbers of such reproductions are to be found in nearly all museums as the only resource to show the art of the times and nations.

During the first half of the seventeenth century, the Dutch merchants engaged most extensively in the earthenware and porcelain trade of China. The potter's art had during this time, extended into Japan and their wares were also traded in by these merchants and distributed over Europe to the great advancement and increasing wealth and prosperity of the Dutch people. This ware took the place of the pewter and woodenware of central Europe and became exceedingly popular all over the world and its usefulness and attractiveness, from its artistic form, coloring and finish, led the Dutch to establish potteries at the town of Delft about 1650.

During the next century measuring from this time, the manufacture of these stonewares or porcelains achieved world-wide reputation, and potteries were established all over most of the nations of Europe,—in Italy, France, Austria, Spain, Portugal, England and Ireland. There were different degrees of excellence in the different nations and different potters, but the manufactures were quite similar in texture, form and general design.

This Delft manufacture led to the experimental stage of pottery for earthenware, stoneware and porcelains. During the latter part of the seventeenth and in the eighteenth century many celebrated factories were established. At Limoges in 1733 soft porcelains were made, and later, hard paste. In 1745, the potteries at Sevre were established. The very celebrated old majolica pottery ware, established earlier but flourishing between 1350 and 1600, originated among the Moors and seems to have had its origin somewhat from the Persians, but earlier than the Delft. In 1750 were established the celebrated Wedgewood factories in England. During the eighteenth century, or between 1700 and 1800, the greatest art and industrial activity of the world was set in operation in the manufacture of all various kinds of earthenware, stoneware and porcelains. The manufacture of beautifully colored and shaped glass was also stimulated and became with porcelains the most popular of all the arts and industries. It not only supplied beautiful household utensils that lifted the scale of life far above the old time of wood and pewter and coarse earthenware, but had a most elevating and civilizing influence all over the civilized world.

The interest in the potter's and glassmaker's art does not decline, and will not more than temporarily at times, as in the past. The general development of these arts and the appreciation of the finest and most beautiful examples are furnishing the finest galleries of art, and bringing them nearer the great artistic beauty of paintings and statua.y as time goes on.

When the finest specimens of porcelain and colored inlaid and murrhine glass, dating back in Babylonia and Egypt to one and two centuries before the Christian era, and including beautiful specimens of ancient pottery from the same periods and nation; and the fine pottery and porcelains of the period prior to the time of the Christian era in the Chinese art, up through to within a century of the present time; and the Persian pottery from the eighth to the eighteenth centuries; the Greek pottery and the beautifully modelled figures of the Greeks, running from the second to the sixth century before Christ; the beautiful irridescent glass of the same period, from the tombs of Syria; the murrhine and inlaid glass of the Romans, from the two or three centuries prior to the Christian era, during which even fabulous prices were paid for specimens of the glass maker's art; together with the later porcelains and the magnificent glass works of the more modern times,—when these are gathered into one collection, they make a most magnificent and beautiful display, one that approaches (from one standpoint) the finest exhibitions of art of the more ancient or even of the modern times. The fine old Kiang-she or Ming vases and some of the fine old Persian that have found their way down through the centuries, the fine old Delft pieces of Pinachre and other celebrated potters, and the later magnificent pieces of Wedgewood and some of the Sevre or Majolica, or the old Greek vases, will probably maintain their commercial values and will increase in art value; and there will be a still higher appreciation of the more modern art, which will come to be taken on its merit as beautiful work independent of its historical value.

The painter's art will probably always remain in the front, but as time goes on, the beautiful colors, forms and finish of the porcelains and glass when made in their highest and most artistic forms will gain even more than they have within the past fifty years.

The potter's art became both the greatest industry as well as art, of the early and mediaeval times. The finest pieces produced became art treasures that were highly prized and were valued at high prices.

Many of the finest pieces were placed in fine cases or boxes lined with silk and cotton and held as accumulated wealth or capital to be used as sources of revenue in case of necessity or as capital to use in trade or industry. The prices at which many of them were held seems excessive compared with values on other things.

November, 1910.

THE WILD BOTANIC GARDEN IN GLENWOOD PARK, MINNEAPOLIS.

By Eloise Butler.

The most interesting features of America to a foreigner are the Indian and his primitive mode of life, soon to become a matter of tradition, and our wild scenery, with its indigenous flora and fauna, which are fast disappearing in the neighborhood of settlements and under the march of so-called improvements. Indeed, to the older residents of Minneapolis most of their favorite haunts in "the deep, tangled wildwood" exist only in memory. The prairie at Minnehaha is burned over annually by mischievous boys; the shy, woodland plants are dwindling out from our river banks; the pools and ponds, teeming with algae, as the microscopic desmids and diatoms of marvellous beauty, many of which were new to the world, have been drained and with the drying up of the water, the orchids, the insectivorous plants, and myriads of other species have vanished, that cannot thrive elsewhere.

Hence the students of botany and the lovers of wild nature have been forced to go farther and farther afield, as to the shores of White Bear and Minnetonka; but even there the land has been platted into building lots and ruthlessly stripped of those exquisite features that Nature, the greatest landscape gardener, has for so many years been perfecting. Many of the cottagers on the lake shores are imbued with conventional ideas of plant decoration more appropriate for city grounds, and condemn their neighbors who are striving to preserve the wildness, for a lack of neatness in not using a lawn mower, and in not pulling down the vine-tangles in which birds nest and sing,—apparently dissatisfied until the wilderness is reduced to one dead level of monotonous, songless tameness.

Again, under favorable, natural conditions, to see all the plants that are in bloom on any given day in Minnesota, would necessitate a journey of many miles, by reason of the differences in temperature and elevation, the varying factors of moisture, soil content, exposure to light, freaks of distribution, and the unequal struggles in the battle for existence.

Therefore, to preserve intact and within easy reach some of our vanishing wild land; to maintain a depot of plant supplies for the schools; to afford an opportunity to study the problems of forestry and ecology at first hand; and to represent, as far as it can be represented in a limited space, the flora of Minnesota—for the benefit of students of botany and lovers of nature—the teachers of botany in Minneapolis and other interested citizens petitioned the park board to set aside a tract of land for a wild botanic garden. The teachers were to supervise the garden and the board were to protect the property and defray the necessary expenses. The site selected by the teachers and generously granted by the board lies in Glenwood Park, the largest and perhaps the most beautiful of all our parks, containing as it does ponds, pools and bogs, a diversity of soil and slopes, and wooded heights commanding extensive views.

The garden was opened the twentieth of April, 1907. It is reached at present by the Bryn Mawr, the Fourth and Sixth avenue north, and the Western avenue street railways and is about a mile from their respective termini. It lies just beyond Glenwood lake, long known as Keegan's on Western avenue, and occupies a depression of land northeast of the boulevard intersecting the park, and is directly opposite Birch pond, one of the loveliest spots in the city.

A particular reason for selecting this place was the undrained tamarack swamp, such swamps being the abode of the rarest and most interesting plants. At first, about three acres were given over to the garden, comprising besides the tamarack swamp, a bit of meadow and wooded slope. Since then, more than twice as much land acquired by a subsequent purchase has been added, that greatly enhances the value of the garden.

A small, winding brook runs through the treeless, eastern portion of the swamp. This has been widened near where it leaves the garden into a little pond, in which is to be cultivated the leading aquatics; and the wayward curves of the brook are accentuated by plantings of forget-me-not, cardinal flower, and other brookside favorites. In the pond also the algae thrive, among them the desmids whose beautiful forms might be utilized in decorative designs for china, wall paper and textile fabrics.

All of the essentials for the growth of plants are found in the garden,—variants in water supply, protection from cold or drying winds, inclines with different exposures, wooded and treeless swamps and uplands, and a rich and varied soil content. Even the sand plants have been provided for by means of an accident—a quantity of sand, heaped up for the boulevard, having been washed by a storm into a portion of the enclosure.

The wild appearance of the garden is to be strictly maintained, and no trace of artificiality nor of human interference is to be evident. Plants are to be allowed to grow as they will, not as people may wish them to grow. Only native or naturalized Minnesotan species are to be admitted, and each plant when introduced is to be accommodated with an environment similar to its original one, and them left to take care of itself as in the wild open, with only the natural fertilization furnished by decaying vegetation. No pruning nor thinning out will be permitted, except what may be necessary for paths by which to penetrate the thickets and for healthful growth. Plants in excess may be removed, when others more desirable have been procured to replace them.

The most abundant trees of the swamp are the tamarack, the canoe and the yellow birch and black ash. More sparsely grow among them red maple, box elder, and basswood; and, among the shrubs are vigorous growths of dogwoods, willows, viburnums, poison sumach, dwarf birch and Ilex verticillata. Bordering the swamp area are the white and the red elm, large-toothed poplar, hackberry, hop-hornbeam, hawthorns, and a superabundance of staghorn sumach, hazel and prickly ash. The undershrubs are represented by rank masses of raspberry, blackberry and wild rose; and the vines by wild grape, Virginia creeper and bitter sweet.

On the uplands flourish the oaks,—the burr, the red, the scarlet, and the white. The largest white oak in Minneapolis is an inhabitant of the garden. It is dying atop, but it is about to undergo surgical treatment to prolong its life. The white birches have crept up from the swamp and mingled with the oaks, among them a beautiful, eight-boled specimen. Twenty species of trees and thirty-nine of shrubs have been identified as indigenous to the garden.

In specifying the herbs mention must be made of the large specimen of Aralia racemosa, or spikenard, growing on the borders of the swamp. Near by the wild calla flourishes in its adopted home and its relative Symplocarpus, the skunk cabbage, one of our earliest bog plants to bloom, for it literally thaws its way through the ice. Deep in the recesses of the swamp are the orchids—coral root, habenarias, and our state flower, the showy cypripedium. Of the orchid family, either indigenous or introduced, are now in the garden six species of cypripedium, eight of habenaria, Orchis spectabilis, Pogonia, Calopogon, Arethusa, two species of twayblade (Liparis), Aplectrum, coral-root, and three species of rattlesnake plantain ,Epipactis). Imbedded in the sphagnum, close by the lady's slippers is the pitcher plant, the only species of this latitude. The pitcher leaves are for the purpose of entrapping insects, with which the plant ekes out its food. An insect seldom escapes, by reason of the inner, slippery surface of the pitchers and their stiff, downward-pointing hairs. The pistil of the flower expands into an umbrella at the top, to keep the pollen and the nectar dry.

In the treeless swamp is an abundance of the tiny, round-leaved sundew (Drosera rotundifolia), another insectivorous plant. The motile, sensitive hairs on the leaves are tipped with glands resembling dewdrops; but which, unlike dew, do not disappear under the influence of the sun,—hence the name, sundew. The leaf is a first-class fly-trap, and the glistening glands contain an active, digestive principle. When a thirsty insect lights on a leaf, the hairs bend over it and firmly grasp it; the more the insect struggles, the tighter it is held; more and more hairs entangle it, and finally the whole leaf rounds over it. The fluid in the globules then oozes out and digests the victim.

Cat-tails abound in the neighborhood of the brook. Near them have been established colonies of sweet flag ,Acorus) and fragrant vanilla grass, used by the Indians in basketry. In their season the rosy swamp milkweed (Asclepias incarnata), asters and golden-rods glorify the meadow. One of the most precious possessions of the garden is the twin-flower named for the great Linnaeus and said to be one of his favorite flowers. The day is memorable on which it is first enjoyed in its perfection. The wild garden is its only station in Minneapolis.

With the Linnaea is found the dwarf cornel, also local in Minneapolis, the herbaceous relative of the dogwood shrubs, valued for hedges on account of their ornamental fruits and stems. The fruit of this cornel is red and edible and is commonly called bunchberry. Other indigenous rarities of the meadow are three-leaved smilacina, Menyanthes, Tofeldia, Chelone, marsh rosemary and the small cranberry (Vaccinium Oxycoccus). Especially prized are the gentians,—the larger and the smaller fringed and closed, all abundant and of magnificent growth. The former, pronounced the most beautiful blue flower of the world, florists have but recently learned how to cultivate. The tall blue lobelia and three eupatoriums,—the pale purple Jo-Pye weed, the less striking boneset, with its grayish flowers, and the pure white-flowered snakeroot—are other adornments of the meadow.

The wooded slopes of the garden are an attractive adjunct by reason of the artistic arrangement of the trees and the rich and varied coloring of the autumnal foliage. In the rich soil under the trees, adjusted to their requisite degrees of moisture are our most conspicuous shade plants, among them Sanguinaria, three species of Erythronium, five of Trilium, and two dicentras,—Dutchman's breeches and squirrel corn.

For the instruction of the unwary harborage is given to poisonous plants like the water parsnip and hemlock, poison ivy and sumach, and to the pernicious parasite, the Cuscuta or dodder, the enemy of the cereals.

On the treeless slopes the prairie plants are well established,—euphorbias, liatras, asters, golden-rods, petalostemums, Vernonia, Heliopsis being the leading genera.

If we make any discrimination, it must be in favor of the ferns, for nowhere else do they grow more luxuriantly. The most spectacular features of the garden are a hillside completely covered with the interrupted fern (Osmunda Claytoniana) and the large clumps of maiden-hair, some of whose fronds measure a foot and a half across.[*] Ten species of ferns are indigenous to the garden and twenty-nine others have been introduced. Hence all the Minnesotan ferns are represented in the place except a few small or rare forms that are difficult of access, like some species of Woodsia and Cheilanthes, and the fragrant shield fern.

In the list of plants the Bryophytes must be enumerated,—among them abundant growths of the liverworts, Conocephalus and Marchantia, and mosses in great variety greening the earth and fallen tree trunks, as sphagnum, Bryum, Leucobryum, Thuidium, Catharinea, Dicranum, Polytricum, Climacium, and the rare Timmæa.

A bountiful harvest of mushrooms is gathered from the garden in their season,--agarics, boleti, polypori, huge puffballs, lepiotas, cup-fungi, and earth-stars. Stumps and fallen tree trunks are carefully cherished to furnish food for them. Tall trunks of dead trees also serve as a support for vines and as homes for birds that live in holes in trees.

Nearly four hundred species of plants have been introduced, embracing seventy-five families and two hundred and twenty-two genera. Together with the rich and varied indigenous flora, the greater number of the most notable plants of the state are now represented in the garden. Maine, Nova Scotia, Massachusetts, New York and Wisconsin have furnished the place with barrelfuls of plants native to Minnesota, but more easily procurable in those states. On account of its geographical position Minnesota has a flora of a wide range, including representatives of alpine, forest, prairie, and drought regions. It is an interesting problem to adjust plants requiring such varying conditions to their life-relations. The largest plantings are made in the spring and fall; but plants often have been successfully lifted when in full bloom, particularly the hydrophytes. Annuals have also been transplanted by sods and have thereafter seeded themselves. But the attempt to establish sweet fern (Myrica asplenifolia) is as yet a failure, perhaps because it requires a poorer, or at least a different sort of soil.

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[*] The ferns indigenous to the garden are,—Botrichium virginiaum, Osmunda Claytoniana, O. cinnamomea, Adiantum pedatum, Pteris aquilina Asplenium filix-femina, Aspidium spinulosum, A. Thelypteris, A. cristatum, Onoclea sensibilis.

The list of the indigenous plants is not yet complete, because many of the smaller herbs mature and complete their course concealed by the surrounding lush vegetation. Indeed, more than once, specimens from abroad have been planted, only later to find them indigenous and plentiful in some overlooked corner of the garden.

What remains to be done is to add the wanting specimens, increase the individuals of the most desirable plants, and to fill in the gaps made by those which die out from lack of vigor or unsuitable environment. A minute topographical survey of the garden is also to be made, and the position of the plants occupying each foot of space mapped out and designated by a reference number in the card catalogue which already records their general location and history.

A wild botanic garden similar to ours in design and scope was established some twenty years ago in St. John, New Brunswick by Dr. George U. Hay, the editor of "The Educational Review" and the writer of Canadian history. At this time Dr. Hay was teaching botany in the high school of St. John, and the immediate purpose of the garden was for the instruction of his pupils. We had supposed that the scheme of our garden was purely original until hearing of this place. My interest was so greatly aroused that I went expressly to New Brunswick to see it.

Dr. Hay's garden comprises about two acres, ideally situated on the St. John river, about twelve miles above the city of St. John, and is reached by the Canadian Pacific railway. It was his aim to bring together as much as possible of the flora of New Brunswick. He told me how the idea came to him. "I observed," said he, "when standing on this very spot, that without taking a step, but by merely stretching out my hand, I could touch eight different species of trees; and the thought occurred to me: 'Since nature has done so much for this place, why cannot I help on the work by doing a little more?'" Dr. Hay's garden is without a swamp, so that some of the plants that happily flourish in ours, lead in his a precarious existence. The essential features of a swamp are, however, somewhat supplied by a broad, winding brook, and his grounds are diversified by hill, valley and meadow. Most of all I coveted his possession of large boulders, which he had completely draped with the rock fern, Polypodium vulgare. How truly Dr. Hay had copied nature in this respect, I did not realize, until, shortly afterwards, I found at Taylor's Falls the very "moral" of those boulders in shape and size, and covered as his was with polypody. Dr. Hay has succeeded in establishing in his garden specimens of all the trees, all the shrubs, and the most notable of the herbs of his province. Northern Minnesota and New Brunswick have many plants in common as the mountain cranberry, Vaccinnium Vitis-Idaea, and the Huron wild tansy, Tanacetum huronense; but I was surprised when he pointed out as a rarity a lonely specimen of a box-elder tree, and again that the hackberry was wanting. His ferns were of great interest, there being splendid examples of massing of the ostrich, royal and lady ferns. Rare and tiny rock ferns peeped out from artfully constructed rockeries, which I supposed were natural, until informed to the contrary. There I saw the shield fern, named for the botanist, Goldie, which Goldie himself never saw growing, but which Dr. Hay had the great pleasure of showing to Goldie's son, when he visited the garden. My attention was also directed to a small specimen of the much bewritten bake-apple, Rubus Chamaemorus, on which a solitary, salmon-colored berry was maturing. During the growing season, many visitors from far and near present themselves in this trained wilderness for instruction and inspiration.

A wild garden is beautiful at all seasons. After the heavy frosts and before the kindly snow covers up in the cultivated gardens the unsightly, bare earth—suggestive of newly-made graves,—and the dead bodies of herbs, and the tender exotics, stiffly swathed in winding sheets of burlap or of straw, awaiting the spring resurrection, I turn with pride and relief to the wild garden, whose frozen ruins are graciously hidden by the shrubs, which then enliven the landscape with their glowing stems and fruits. And how lovely are the waving plumes of the grasses, how endless the varieties of seed-pods, how marvellous the modes of seed-dispersion! The eye, no longer distracted by the brilliant flower-mosaics, sees the less flaunting beauty and rediscovers "the commonplace of miracle."

I am not an enemy of formal or cultivated gardens; although I love wild gardens more and think our native plants superior, for the most part, to foreign ones in beauty and appropriateness. For plants from abroad, torn from their natural setting, often make a false note in the landscape. Cultivated gardens have their place, are seen at every hand, and need no advocacy. In fact, the founders of the wild garden are desirous to establish an artificial, botanic garden in connection with the wild one, wherein may be reared all the leading plants of the world that can grow in this climate; thus gratifying all tastes and affording at the same time inestimable advantages to students.

Why may not a large portion of the extensive Glenwood park be used for this purpose? Why can we not duplicate in Minneapolis the Shaw Gardens of St. Louis, the Bronx Gardens of New York city, or the world-famous Arnold Arboretum of Boston? Barring the primeval hemlock grove, Glenwood park has more natural advantages, as water supply, fertility and variety of soil, than the Arnold Arboretum. Such a garden would add greatly to the fame and attractiveness of Minneapolis, and would be second only to the public library in its educative and refining influences.

NOTES ON THE ELEVENTH INTERNATIONAL GEOLOGICAL CONGRESS HELD IN STOCKHOLM, AUGUST 18-25, 1910

By Horace V. Winchell, Dec. 6, 1910.

To this convention of geologists was accorded the patronage of His Majesty the King, Gustav V. The Honorary Presidency was held by His Highness Prince Royal Gustavus Adolphus, himself a scientist of repute, and a most accomplished linguist. His opening address, delivered in English to a polyglot audience, was as masterly, polished and in every way worthy a performance as if composed and presented by an American College President. The Executive Committee contained several members of the Swedish cabinet; and the Prime Minister also delivered an address, opening the discussion on the Iron Ore Resources of the World. The president of the Congress was Baron Gerard De Geer, Professor of Geology at the University of Stockholm, and a celebrated glacial geologist. The able and efficient secretary was Prof. J. G. Andersson, Director of the Geological Survey of Sweden. For nearly a year his entire time had been devoted to the task of providing the program and the entertainment for the large number of foreign members expected. The magnitude of such an undertaking may be partially comprehended when I tell you that there were about eight hundred enrolled and that more than two hundred and fifty took part in one or more of the excursions which began a month before the opening of the Congress and were still in progress for nearly a month after its close. The arrangements were complete to the last detail; and the executive ability of the Swedes compelled the admiration of every visitor to the Congress.

The membership of the convention was truly cosmopolitan, as may be seen by the following table of members enrolled before the day of opening:

Algeria	3
Germany	161
Argentine	2
Australia	2
Austro-Hungary	64
Brazil	1
Bulgaria	2
Canada	6
China	1
Denmark	22
Egypt	3
Spain	9
United States	63
France	53
Great Britain	44
India	1
Italy	30
Japan	6

Mexico	7
New Zealand	2
Holland	13
Portugal	4
Roumania	9
Russian Empire	56
Sweden	134
Switzerland	16

Among the notable geologists present were Richard Beck, author of the treatise on Ore Deposits; Alfred Bergeat, Dr. Groth, Max Krahmann, Paul Krusch, Dr. Lepsius, Penck, Stutzer, from Germany; Dr. Kremer, Carl Diener, Dr. Doelter, and Dr. Tietze, from Austria; F. D. Adams, A. P. Coleman, B. E. Fernow and W. G. Miller, from Canada; Dr. Steenstrup, from Denmark; Miss Bascom, Geo. F. Becker, Whitman Cross, Arthur Day, S. F. Emmons, Arnold Hague, C. R. Van Hise, W. H. Hobbs, J. D. Irving, J. F. Kemp, Waldemar Lindgren, D. H. Newland, H. F. Read, J. T. Singewald, J. W. Spencer, R. S. Tarr, E. T. Wherry, J. E. Wolff, F. E. Wright, Geo. Otis Smith, and others many of them accompanied by their wives, from the United States; Profs. Barrois, Margerie, Nicou and Oehlert, from France; Prof. Bowman, J. W. Gregory, Drs. Peach and Teall, of Great Britain; Dr. Fermor, of India; Capellini, B. Lotti, and others from Italy; Inouye, Director of the Japanese Geological Survey, and several other Japs; Aguilera and Ordonez from Mexico; Brögger, Reusch and Vogt, from Norway; Molengraaff, from Holland; Stefanescue, from Roumania; Karpinsky, Pavlow, Popoff, Revoutsky, and Tschernyschew, from Russia; Sederholm, from Finland; all the Swedish geologists, including Sven Hedin; Heim and Schmidt, from Switzerland; and many others of high reputation.

The excursions included ocean voyages to Spitzbergen in the Arctic Ocean, and the island of Gotland in the Baltic Sea. Other trips were made by special train from north to south in Sweden and Norway, furnishing a rare opportunity for seeing under the best possible auspices and chaperonage those localities where are exhibited the typical features and points of interest to students of structural, glacial and economic geology, and to the petrographer as well.

Thus at Spitzbergen were seen the magnificent glaciers on the margin of the sea, advancing, retreating or stationary. There were studied moraines of various types, the movement of complex glaciers, the deposits of glacial rivers and lakes, and all those various agencies now in operation, performing the same work as that by which was formerly deposited the glacial drift mantle over the state of Minnesota.

At Spitzbergen also is an excellent opportunity for the study of a mountain range folded and ruptured on the border of the Atlantic basin, and containing formations of different ages, from the Archean to the Quaternary. Here can be seen the origin of the fjords, those long narrow coastal inlets which make the coast of Norway, Scotland and British Columbia so picturesque and attractive to the tourist. The clothing appropriate for this excursion in July is that which we wear in Minnesota in November.

Excursions were also made before the Congress to the iron mines of northern Sweden; and another excursion after the Congress took us to the mines of central and southern Sweden. Others were made to Tornetrask, the alpine lake of the mountainous country in the north, and to the valley of the Luleälf, with its eruptive and metamorphic rocks, its glaciers and mountain climbing. Here the nights were spent in tents, and the days were full of laborious tramping.

In the vicinity of Stockholm excursions were made almost daily during the week of the meeting, always under the guidance of some star of the geological firmament, and always with the satisfaction of having seen with our own eyes phenomena of which heretofore we may have read and regarding the interpretation of which we were, perhaps, at heart somewhat skeptical.

And for each excursion and each locality there was a printed guide and description. For each day's work there was a plan. Almost was there a daily assignment for each individual guest. His comfort, conveyance, lodging, and three or more meals for each day had all been arranged beforehand.

The descriptive literature was today in German, tomorrow in French, and next day in English; and most of the Swedish gentlemen could converse or lecture in all three as well as in their own tongue. In fact, they sometimes caused a laugh by unconsciously lapsing from German or English into Swedish.

The Russians spoke French fluently and usually some English. The Germans spoke some French; the French a little German; and both of them could generally understand some English.

Besides our badges, we also wore ribbons; red, to show that we spoke German; white, for English; and blue, for French. Proud and fortunate, indeed, was he who sported all three. The English were the poorest linguists and most limited in their command of any tongue but their own.

Personally the Scandinavians are charming people, hospitable, generous, courteous, thoughtful, agreeable in conversation, cultivated and travelled. They are new and virile, without being raw and crude. Up-to-date in the adoption of modern inventions, ahead of us in some ways and in the van of modern progress in all. They are one of the most progressives nations in Europe today, and are more than holding their own in the march of development.

The museums of Stockholm are full of the most interesting and complete collections of human remains of the stone and bronze ages. Brief and measurable is the time that has elapsed since the Goths and Vandals were just stepping out of the bronze age; and here are their immediate descendants engaged in scientific studies and in all the activities of an ultra modern people! Think how interesting it would be if we could go out into the country only a few miles and discover the remains of our own great-great-great-grandfather's dwelling. If we could find in it the furniture and utensils which he and his family used, the ornaments they wore and the relics of the very food they ate. This is done in Sweden. They do not there find tumuli and say indifferently, "It was done by the Mound Builders." The ancient human relics are those which tell of the habits and civilization of their own people in the prehistoric times. They are, therefore, personally and intimately interested in such matters, and point proudly to the extent of their progress and development in a short time. And from this development they expect still greater things in the future.

The area of Sweden is 173,921 square miles; that of Norway 125,615 square miles. The two together are, therefore, somewhat larger than the state of Texas. The population of Sweden is about 5,150,000, and of Norway 2,250,000. Together the two countries have a population about equal to that of the city of London. There are only five cities in Sweden with a population of more than 30,000: Stockholm, Göteborg, Malmö, Norrköping and Gefle.

Half of its population is supported by agriculture; and about one-quarter own their own farms. The crops are varied, consisting largely of grain, hay, sugar beets, hemp, flax, potatoes and small fruits.

The exports from Sweden amount to more than $100,000,000 annually, of which over half goes to Great Britain. The products exported are timber, iron, butter and wood pulp.

Forests are abundant and well cared for. South of latitude 64° N. one-fourth of the entire land is forested. In southern Sweden and Norway, as well as in Denmark, are venerable forests of solid oak and beech. Much charcoal is made for use in iron ore smelting.

Lakes and rivers are numerous. The more important streams flowing into the Baltic are the Tornea, Lulea, Pitea, Skelleftea, Windel, Umea, Angermann and Dal. Into the German ocean flow the Klar and Gota. The largest body of fresh water, lake Wener, has an area of about two thousand square miles.

Much of the southern half of Sweden is lowland. Toward the north the country is more elevated, and a range of mountains lies on the border between Sweden and Norway. The highest mountain, Kebnekaisse, in Swedish Lapland, rises to the height of only about seven thousand feet.

The climate is good. Winters are long, and the summers hot. There is but little Spring and Autumn. The influence of the Gulf Stream is marked; and the western coast of Norway, at the same latitude as our ice-bound Bering Sea, is as mild as our climate at New York or Boston.

Nearly all of the interesting features of Sweden's geology were described in the forty little monographs prepared by the Swedish geologists and published in convenient form for our use at the Congress and upon the various excursions.

There is time this evening for only a brief abstract of a few of the most important and interesting of these papers.

For the glacial geologist there was an illustrated lecture and article upon the "Quaternary Sea Bottoms of Western Sweden" and an account of "Some Stationary Ice Borders of the Last Glaciation" by Baron Gerard De Geer. In the first of these articles it is pointed out that the land ice was possessed of but feeble power of glaciation, and that instead of eroding deep gorges and valleys and planing off hundreds or thousands of feet of solid rock, its direction of flow was determined by the valleys coincident in strike with Tertiary rock fractures and dikes; and the work of the ice was limited to the sweeping out of the crushed material to the extension and depth predestined by the pre-Quaternary act of crushing. The ice sheet's power of glaciation, working during the whole length of the ice age, is said to have been unable to obliterate or essentially change the surface topography; and only put its stamp upon the landscape by grinding off the proximal ends of the rock edges to the well-known ice-worn "round-rocks."

The origin of giant-kettles or pot holes is explained through the characteristic corrosion by sub-glacial rivers where such currents pushed forward by a strong hydrostatic pressure passed over rock ledges so as to form sub-glacial whirls. The assumption frequently made that these kettles were formed by water falling down through crevasses is found untenable, at least when applied to the many low-lying kettles, which at the time of their formation, were situated at a considerable depth, even as much as three hundred and twenty-five to five hundred feet below the surface of the sea. In such cases even the crevasses must evidently have been filled to at least the same height by standing water, and it does not seem likely that a water fall could bore out holes in the bed rock through such a depth of standing water. The extraordinarily strong rapids of the sub-glacial rivers were no doubt more than sufficient to produce even giant's kettles of such imposing dimensions as those sometimes found in Bohnslän, some ten to twenty feet in diameter.

The late glacial recession of the ice proceeded at a much greater speed on the continental than on the oceanic side of Sweden. Thus the recession of the ice border through Bohnslän and the adjoining part of the province of Dalsland took the same amount of time as the whole recession from the south end of Sweden up almost to the Aland archipelago, i. e., over three thousand years.

By means of the deposits of fine glacial clay carried by sub-glacial rivers out into the advancing ocean as the ice retreated, it is ascertained that the late glacial sea covered a large part of Denmark and extended to central Sweden and Norway, and that there were important changes of land and sea level, amounting to hundreds of feet. There were for example great shell deposits of shallow water forms laid down where the water had been previously more than three hundred and twenty-five feet deep.

A careful study of the layers of clay and sand deposited in the late glacial sea has furnished a most accurate measure of the chronology of the retreat of the ice sheet. Baron De Geer points out that, while there were many variations in the rate of recession of the ice margin, the average rate of retreat in the vicinity of Stockholm was two hundred meters per year. South of Stockholm for some distance the rate was from twenty to one hundred meters per annum. At some points to the north, notably near Dal's Ed near lakes Venern and Vettern, the ice border remained stationary for one hundred or two hundred years.

Baron De Geer's estimate of the lapse of time since the retreat of the ice at Stockholm is about seven thousand years. Farther north the ice lasted until a much later period; and the northern part of Sweden was probably covered with ice only two thousand years ago.

It may be remarked in passing that this estimate compares well with that made first in the gorge of the Mississippi river by Prof. N. H. Winchell, as well as with the later similar measurements by Gilbert and Spencer at Niagara Falls.

For the student of the Archean there is a splendid field in Sweden. The rocks are fresh, glaciated and exposed to view on sea coast, along the new river courses and on the mountain sides. Everywhere the landscape reminds one of Minnesota and Ontario, and, like Minnesota, Sweden has many great iron mines. In fact, there is found a greater variety of workable ore deposits than has thus far been discovered in our Archean territory. To the economic geologist, Sweden is one of the most interesting countries on the face of the round globe. Its great age as a center of mining, the magnitude of its deposits and their unusual types provide material for innumerable "kolossals" and "wunderbars" of the Teuton and challenge the utmost exaggeration of the Yankee to suggest their equal in his own land. Historically, mining operations here are lost in the mists of antiquity. Methods and machinery had established vogues and patterns three hundred and fifty years ago in the days when Agricola, the Nestor of mining, published his classic treatise. Indeed, some of the machinery pictured by him in 1556 still finds its counterpart in Swedish iron and copper mines, steadily doing duty side by side with electric hoists or smelting plants of the most up-to-date design.

Although paleozoic and mesozoic strata are found in Sweden, yet the larger portion is covered by the Archean rocks, gneisses, schists and intruded rhyolite and porphyries. These eruptives have been in many instances profoundly altered, and the ancient ore deposits, which they were instrumental in producing, have undergone a varied and unusual history.

The Swedish Archean consists of three petrographically and geologically different groups of rocks. These have long been named: The gneiss-group, the porhpyry-hälleflintgneiss group, and the granite group. Recently an alteration was made in this terminology by the exchange of the term "hälleflintgneiss" for leptite, the latter having been proposed already in 1875 as a collective name for the same rocks.

The porphyry-leptite group, as the new designation also runs, includes fine-grained gneisses, schists of many types, also green schists, dense rocks, called in Sweden a long time ago "hälleflinta," limestones, dolomite and argillaceous schists, quartzite and conglomerates together with porphyries and porphyroid rocks to a large extent. Many of the rocks of this group bear evident traces of having once been formed as real surface-products of the earth: lavas, tuffs, tuffites or normal sediments, the latter, however, being only subordinately represented in the Archean. The leptites themselves, which form by far the greatest part of this group, are closely related to the other rocks and seem to be metamorphosed rocks of volcanic origin: lavas, tuffs or tuffites. Consequently the "porphyry-leptite group" corresponds very well to the designation supercrustal rocks, which has newly been proposed by the eminent explorer of the Fennoscandian Archean, Dr. J. J. Sederholm.

Supercrustal rocks also form a great part of the gneiss group, but the high-grade of metamorphism which designates the gneisses, mostly conceals their primary petrographic character and geological relations so as to make their origin in many cases doubtful. The gneiss group includes also gneiss-granites. By this term Swedish petrographers understand granites of strongly regional metamorphic character, i. e. crushed, foliated or granulated granites, often with a clearly marked secondary parallel structure.

The third group is the granite group. This embraces all the numerous types of granites, in which the Swedish Archean is so very rich. Great areas of Sweden consist of these rocks. Together with the gneiss-granites they certainly make up much more than 50 per cent. of the whole Archean system. The contacts show that the granite-magmas have cut all the other rocks and they must, therefore, be considered younger than these rocks. Their properties are those of real plutonic eruptives. Together with the said gneiss-granites and the gabbros and diorites, which appear in smaller quantities, the granites may be said to form the infracrustal rocks of the Archean, in accordance with the nomenclature of Sederholm.

In the coast-regions, east and south of Stockholm, gneissose rocks predominate; yet the granites and the porphyry-leptite-group are also very well represented.

Of the gneisses there are found both supercrustal and infracrustal types. The origin of some gneisses cannot yet, however, be stated with certainty.

What is known as the porphyry leptite group of rocks is associated with iron ores in central Sweden and also in the coast regions near Stockholm, extending along the coast to the islands Utö, Ornö, Namdö and Runmarö. The rocks are hälleflintas, leptites, mica schists, porphyry, epidote-or amphibole-bearing green schists, calcareous schists, limestones and iron ores. They are all bedded, often regularly and with alternations which make them closely resemble stratigraphical complexes. Their structures are, however, wholly crystalline and the bedding planes are now always nearly vertical.

The iron ore at Utö is the type known as "randig blodsten," i. e. quartz-banded hematite similar to our jaspilite. The quartz is gray or reddish, and the iron ore is hematite with more or less magnetite. Beds of amphibolitic rocks accompany the ore and thin green layers alternate with the iron ore strata. The mines at Utö were worked as early as the beginning of the 17th century, and operations continued down to 1879. From 1711-1878 the output was 2,070,900 tons of iron ore. The total production is estimated at 2,500,000 tons. The ore was not high grade, containing before concentration but little over 40% of iron. The Nyköping mine was worked to a depth of about 650 feet, and the Finn mine about 500 feet.

Two famous lithia pegmatite dikes cut across the folded iron ore body of Nyköping. Here the element lithium was first detected by Arvedson, a pupil of Berzelius, in 1818. These dikes are among the most important known natural resources of lithia. The dikes consist mainly of petalite, quartz, lepidolite and coarse green orthoclase. They also contain spodumene, blue and red tourmaline (indigolite and rubellite), microlite (a tantalate of lime), mangantantalite and adelfolite. One of the most amusing sights of the tour was to see the Germans with hammers of all sizes up to that which tradition ascribes to the War God Thor, descend upon a mineral locality. No classic exposure was sacred. The best is none too good for an unmodified Teuton, and the baggage car attached to each special train was so loaded with rocks that hot boxes were numerous. For pure unadulterated selfishness the average German has not an equal in northern Europe, and his manners would shock an Eskimo.

Adjacent to the iron-bearing hälleflinta zone of Utö is a mighty series of limestone and hälleflinta. The limestone is finely crystalline and alternates with the hälleflinta in bands from only a few centimeters to several meters in thickness. Where intensely folded and crystallized the hälleflintas resemble amphibole schists; and, indeed, the bedded complex is bordered on the east by a thick layer of green amphibolitic rock containing thin limestone layers. This green rock resembles the green skarn or gangue rock of the iron mines farther north.

Associated with these rocks is a greenish gray bedded leptitic hälleflinta which likewise contains a few thin beds of limestone. Then comes the regular bedded leptite, containing layers of nearly massive porphyritic rocks, which are undoubtedly altered lava beds and tuffs. The leptite is cometimes quartzitic and almost itself a quartzite. It is composed of quartz, feldspars, biotite and muscovite.

There were silver mines also at Utö. Native silver occurs mingled with epigenetic sulphides of copper, iron, lead and zinc. The mines are not now operated and were never important.

The hälleflinta here is looked upon as a volcanic mud. It is a quartz feldspar sediment, mingled with volcanic ash and sedimentary limestone. It is even occasionally coal-bearing. The iron ore is regarded as a chemical sediment.

Passing from the coastal region to the central portion of Sweden, we come to the university town of Upsala. If Stockholm is the Venice of the North, Upsala is surely the Boston of the Arctic. Here for hundreds of years has been a center of learning and culture. Here lived and wrote Sweden's greatest scientist, Carl von Linnaeus; and his house, with all of his natural history collections, is still preserved on the old farm, a couple of miles outside of the city. The main university building is a fine structure, on an eminence, surrounded by statues of some of its celebrities and containing oil portraits of many others. Near it is the Upsala Lutheran Cathedral, which is one of the notable structures of the country.

Not far from Upsala are Dannemora, Sala, Krylbo, Karrgrüfvan, Norberg, Hagge, Ludvika, Grängesberg, Persberg, Ammeberg and Falun.

Like many other Swedish iron mines, Dannemora was first worked for precious metals. The date of its discovery is approximately fixed by a deed of gift dated 1481 by which Sten Sture, the Elder, conveys to the Archbishop of Upsala and his successors one-fourth of the silver mountain in the parish "which was discoverd a a few years" before.

When Gustav Vasa secularized the church lands, the mine reverted to the crown, and was first leased to Joachim Piper, a burgher of Stralsund in 1532. Iron ore was still only a subordinate product mentioned along with "sulphur, vitriol, antimony, lead, tin, copper, silver and gold." By 1545 iron ore production had become important, under a lease from the crown. Later, in the 17th century, the works and mines passed into the possession of private owners.

Gunpowder for breaking the ore was first tried at Dannemora in 1728; and in 1727 a wonderful "fire and air engine" was set up for raising the water. In 1805 a steam engine of Watt's construction, the first in Sweden, was installed.

The rocks at Dannemora are crystalline schists with intrusive granites. There are also other intrusive dikes. The Dannemora ore district is chiefly occupied by hälleflinta, and the porphyritic hälleflinta has the greatest extent. It almost encloses the limestone and other varieties or phases of the hälleflinta. This so-called porphyritic hälleflinta consists of a dark colored microcrystalline fine grained quartz feldspar rock with a rich admixture of a sericitic mineral of secondary origin. Chemically, it is an acid quartz porphyry. Many varieties in color, texture and geological relations occur in this field; and north of lake Grufsjön it passes into granulite or leptite.

The ores are enclosed in a limestone mass, which is in turn surrounded by the hälleflinta. This limestone has a length of about three thousand meters and a minimum width of about four hundred and fifty meters. Composed exclusively of magnetite, the ore has a characteristically fine-grained structure, often as compact as steel. It occurs associated with skarn or gangue (called "bräcka") and more or less mingled with limestone. The percentage of iron varies from 20% to 65%.

The more important ore deposits belong to a number of complexes, some of which contain several parallel ore layers. In each complex there occur several independent ore-stocks, separated by limestone or "präcka." Such ore stocks may be connected with other ore stocks in the direction of the pitch or toward the depth. They are usually nearly vertical. Their horizontal extension in the line of strike may reach two hundred to three hundred meters and their thickness thirty to forty meters.

The mines of the central field have been opened from the surface on several ore-bodies of great thickness, partly separated by gangues and branching toward the north. On the south this extensive ore-formation is almost entirely cut off by a system of parallel chlorite leaders, which form the southern wall of the Hjulvind mine, and somewhat resemble a fault. These chlorite bands or sköls were probably originally diorite dikes which acted as a dam in cuttting off the ore injection or the solutions by which it was formed.

Quantities of sulphides, chiefly zinc blende, have been introduced metasomatically at a later period, impregnating both the ore and the later granite intrusions.

The mines of Langban have produced small amounts of argentiferous galena and sphalerite and considerable quantities of manganese and iron ores. Here, as elsewhere in central Sweden, the ore-bearing formation is the crystalline schists. They are here chiefdolomite, which is characteristically banded by lime magnesia silicates, except adjacent to the ore and sköl.

The ores occur in stockworks, usually containing both iron and manganese. There appears to be a tendency to scatter and diminish in importance at moderate depth. The gangue of the iron ore shoots is called "skarn" and is of varied color and mineral composition, containing gray-green malacolite, brown and black garnets and ferruginous quartz. There are also unimportant deposits of sulphide ores of copper, iron, lead and zinc. Many sköl layers or bands bound the ore and extend thro the adjacent rocks. In some instances these sköls are squeezed and altered greenstone dikes that seem to have been present before the ore was deposited, and to ly granulite and dolomite. Closely associated is a gneissic granite. Two varieties of younger intrusive granite dikes occur, and various still later diorite and diabase dikes. Pure dolomite bears such a constant relation to the ore or sköl formations that it is concluded that the ore-depositing agencies had a marked effect also upon the have formed a boundary to it or determined its extent. In other cases the sköls are more or less micaceous and represent transformed granulite or leptite. Still other occurrences resemble very old shear zones or fault planes whose filling has been transformed into crystalline rock material. Still later fracturing has occurred, and the cracks have been filled with calcite and other secondary minerals.

In this same neighborhood are also the mines of Norberg, Flogberget and Persberg. The principal features of interest are the "skarn" ores and the calcareous ores, the former of which are hornblendic magnetites and the latter serpentinous and amphiboliferous limestones intermingled with small patches and lenses of skarn ore.

Persberg is one of the oldest mining fields in Vermlands Bergslag. Mining dates back to the 13th century; and the first mining privileges were granted by King Eric the Pomeranian in 1413. The Bergmaster's report for 1637 states that "the whole mountain is nothing but ore, and of mighty richness, and can be smelted without flux," from which it can be seen that the art of writing mining prospectuses based largely upon the imagination did not originate in the United States. The total output of the Persberg mines is estimated at less than 4,000,000 tons. Fifty years ago the annual production was about 50,000 tons. At the present time it is about 30,000 tons. The ore is of excellent quality and has contributed largely to the reputation of Swedish iron in the world's market. The best grade of ore contains 55½ Fe, 0.001—0.004% P; and the second grade 45% Fe and 0.005—0.01% P. The sulphur content varies from 0.012 to 0.025%. The deepest workings are now about 1,000 feet. Machine drilling was first started in Sweden at Persberg in 1864-1866. These mines were well described by Linnaeus about 1746. Powder for blasting was introduced about 1720.

The skarn ores are believed by Sjögren to owe their origin to the metamorphic influence of greenstones upon limestones. There are, however, considerable ore-deposits which are, so far as can be seen, without any immediate limestone association. The granite eruptives may also in some instances have been active mineralizing agents. Granulite or leptite is abundant, cut by skarn zones, which contain the ores.

The history of the Sala lead and silver mine extends over four centuries. The ore deposits seem to have been discovered early in the 16th century, being mentioned in a document dated September 1, 1510. Its palmy days were in the early half of the 16th century, when it furnished an important part of the public revenue. By 1571 mining operations were difficult on account of water. Kings Carl IX. and Gustavus Adolphus both tried their hands at it; but for fifty years only little progress was made. The grade of the ore declined with greater depth, and renewed exploration in the upper levels discovered more ore once in the latter part of the 17th century and again a hundred years later. It is stated that the mine was worked at a loss during the whole of the 19th century. At present an effort is being made to utilize the zinc ores that were left in the mine by former operators.

The total production of silver of the Sala mine is estimated at about 400 tons, of which about one-half was produced in the 16th century. Sjögren states that from an economic point of view the mine was run at a loss for three centuries. It was kept going only by means of special privileges from the Crown.

We find here again the crystalline schists or basal complex of hälleflinta and limestone, cut by granite and porphyrite intrusions and by later diabase dikes. The carbonate rocks are most closely connected with the ores. The galena is found chiefly in the limestones and only to a very subordinate extent in the hälleflinta. Copper ores also occur in the limestone; while small iron mines in the district are connected with the hälleflinta.

This latter rock here presents an extremely varied formation whose only common character is the felsitic texture of the groundmass. It is dark, or light gray or brownish, and is sometimes striped or banded. A few varieties have a purely granitic or quartz-porphyric constitution; in general, however, the percentages of alkali are lower than in the quartz and felsitic porphyrites, and the constitution corresponds rather to that of the dacites and quartz-porphyries, with which rocks the hälleflinta also shows points of agreement in the quantity of Fe—Mg silicates. On the whole, the rock in its composition stands closest to the intermediate eruptives. The percentage of lime, which preponderates over that of Mg, and the often considerable percentage of Na, which often outweighs the K, forbids the interpretation of it as a metamorphosed sedimentary rock. It grades into the dolomite limestone both by an increased percentage of the calcareous material and by close interbanding.

The fact was noted at an early date that the ores declined in richness toward the deep. This phenomenon, which is not peculiar to Sweden, is commonly ascribed to secondary enrichment from the surface downward; but Prof. Sjögren, to whom we are indebted for a description of many of these mines, and who went with us as guide, philosopher and friend, does not accept that theory here.

Before leaving central Sweden mention should be made of the Grängesberg iron ores. They occur in the usual formation of gneissic rocks, called granulites or hälleflinta gneisses or leptites. Included in this formation are also amphibolitic or dioritic greenstones, skarn rocks, crystalline limestones and iron ores. Later granitic and diabasic eruptives are also present.

The ores are (a) apatitic; (b) quartzose hematites; (c) skarn ores, and (d) calcareous ores; the latter two as well as the first being non-manganiferous, non-titaniferous magnetites. The iron content varies from 55% to 65%; and the phosphorus from 0.1% to 8%. Thus the mineral apatite sometimes amounts to more than 40% of the ore.

The low grade magnetite ores of central Sweden are now being concentrated on a considerable scale. The process most favored in that country is called the Gröndal process from its inventor.

The raw ore containing from 27% to 55% iron is broken in a crusher, and ground to sand in a ball mill. The magnetite sand or concentrate, containing 67% to 71% iron, is taken out by magnetic separation, moistened and moulded into bricks about 6 inches square and 2½ inches thick. No binder is used. The bricks are simply pressed and moved slowly on iron conveyors through a furnace heated with generator and furnace gases and subjected to an oxidizing flame at the temperature of about 1400° C., which is above the sintering heat. In these furnaces the magnetite is changed to hematite, the percentage of sulphur is lowered, and a hard porous briquet is made very suitable for the blast furnace. By this process, at a cost of about eighty cents per ton, some twenty-seven Gröndal furnaces are turning out about 300,000 tons of briquets per annum. Since magnetite briquets require about 300 pounds of charcoal per ton of pig iron more than those made of hematite, the expense of the briquetting is justified in a region of sulphurous magnetite ores. This process is of special interest in Minnesota because of the large quantity of low grade magnetite ores on the eastern end of the Mesabi range, at present unmarketable.

There remains for description in central Sweden what is historically one of the most remarkable mines in the world, viz: the Falun copper mine. Worked without interruption for the past six hundred and fifty years, it had down to the end of the 19th century produced more copper than any other mine on the globe. From 1630 complete records of its production are extant, according to which the total output in that time amounts to nearly 300,000 tons, or 600,000,000 pounds of copper. From the commencement of mining operations to the present time its output has been estimated at 500,000 tons of copper, one ton of gold and fifteen tons of silver, having an aggregate value of $250,000,000. For the sake of comparison we may note that in these days of monumental performances the total estimated copper output of the Falun mine in six hundred and fifty years is about equal to three years' production of the mines of Butte.

The ore was formerly richer than in later years, and the possibility of secondary enrichment is again suggested. At present the mine is worked for pyrite, which is used in the sulphite pulp digesters belonging to the company which operates the mine.

This corporation, by the way, although one of the oldest in existence, is one of the most progressive and profitable concerns in Swdeen. The date of its actual foundation is not known; but it is supposed to be about the year 1225. There is in existence a deed dated 1288 conveying certain shares of stock; and one charter of the company, given by King Magnus of Sweden and Norway, is dated February 24, 1347, and at that time ratifying and confirming the company's rights and privileges which are mentioned as very old.

The company, whose full address is Stora Kopperbergs Bergslags Aktiebolag, Falun, Sweden, began to make or produce

Copper about the year		1225
Sawn lumber in the year		1689
Iron		1735
Gold and silver		1790
Steel	Bessemer	1871
	Open hearth	1878
	Electric	1904
Pulp	Soda (sulphate)	1895
	Sulphite	1900
Paper		1900
Bismuth		1904

It owns vast forests, two hundred iron mines, and water-falls estimated at 150,000 horse power. It makes the specially soft charcoal wrought iron for which Sweden is famous. Its annual production is

75,000-100,000 tons pig iron.
70,000 tons Bessemer ingots.
26,000 tons open hearth ingots.
4,000 tons charcoal iron blooms.
75,000-100,000 tons rolled and hammered iron and steel.

It uses 450,000 cubic meters of charcoal per annum, making 150,000 cubic meters in its own kilns.

The Falun mine, called "The Country's Treasury" by Gustavus Adolphus, is 1200 feet deep and has about 18 miles of underground workings. The bottom of the mine is now full of water, and many of the old workings are inaccessible. During the first 400 years of its history the ore was broken by burning wood against it. Gunpowder was first used in 1729. The ore was raised by means of windlasses worked by hand or horse power, and the ropes were made of ox-hides, 200 to 300 hides being required for a single rope.

The country rock at Falun is the crystalline series in the form of gray gneiss and granulite or leptite. The gneiss is locally a quartzite which is the true ore-bearing rock, and to it belong also the other copper ores of this and adjacent districts. It contains as accessory minerals amphibole, cordierite and its alteration products, falunite, andalusite and magnetite. There is also considerable white saccharoidal limestone. Composite basic dikes also occur, cutting both ore and country rock.

The ore of the Falun mine is pyrite of various modes of occurrence, and more or less associated with sulphides of lead and zinc. In the upper levels the ore was considerably enriched, and probably contained the higher grade copper sulphides. Occurring in stocks of bluntly conical form with the point downward the interior structure of the ore bodies cannot now be studied. They consisted largely of nearly pure pyrite with a slight percentage of copper. There was also a quartzose mixture of copper pyrite and pyrite containing angular fragments of quartzite and limestone.

There is here also a considerable development of skarn at the contact of quartzite and granulite. It consists of a dark green mass of radiate amphibole sometimes garnetiferous. Then there are sköls more or less closely connected with the pyrite stocks and surrounding them or separating them from the other rocks. The sköls consist partly of primary minerals, such as amphibole, biotite and cordierite and partly of their hydrated derivatives, chlorite, talc and falunite. There are also secondary garnets and magnetite octahedrons and later sulphides. The sköls sometimes have a thickness of ten to fifteen meters, and again they thin out rapidly. They grow smaller in depth and have in general a development proportional to the extent of the ore mineralization. The richest ores the mine ever produced came from the upper zones of the sköls.

The "hard ores," so-called, lie immediately in the quartzite without being enclosed by sköls or leaders, and pass by insensible gradations into the rock itself. All the ores appear to come to an end at the maximum depth of 250 to 280 meters.

Gold occurs associated with galenobismuthite, in small quartz veinlets. Some selenium has also been found associated with trap dikes which contain amphibole in a felsitic ground mass of quartz and plagioclase. The gold ore was richest at the depth of from 40 to 100 meters. Workable gold ores have not been found below 200 meters.

The surface of the pyrite and neighboring limestone in some places retains the grooving and striations of the glacial period. It is interesting to note that there has been barely perceptible oxidation and solution in the five thousand or more years that have elapsed since Jack Frost here made his mark.

One of the memorable events of the trip was a luncheon held deep underground in an old stope in the Falun mine. Lighted by a thousand candles, and with a blazing fire in an old rise connected with the surface, the table spreads dazzled us by their whiteness against the dark rock background, and the glasses and silverware sparkled with unusual brilliancy. Here in this immense chamber had worked miners before the discovery of America. The marks of their tools remain, and the place where the last pile of burning faggots hollowed out the solid ore, or the face of the drift smooth and rounded instead of rough and jagged as when made by explosives, conveys a faint idea of the infinite slowness and labor with which the work of mining was carried on. Here on the rocks are carved the names of rulers and nobles long since passed away. Even the room itself bears the name of "Algemeine Frieden", or Universal Peace, given to it at a celebration after the battle of Waterloo.

After luncheon speeches were in order and then a German mining song led by Graessner and sung to the finish with increasing gusto and effect. Our way to the surface and daylight was up the easy steps cut in the rock, where climbed the miner in the days of the Reformation, and where even before that time sat Roman foreman with old-style candles, counting the men as they passed. It was all impressive and made us feel small and new and insignificant.

From the oldest and most important copper mine in Sweden we passed in two days' travel almost straight north to the youngest iron mine in Sweden and the largest in the world. This mine is in Swedish Lapland, and is called Kirunavaara or Ptarmigan mountain. It has been opened and put in operation during the past ten years under the management of a Swedish Captain of Industry named Hjalmar Lundbohm.

Here within the Arctic circle, North latitude 66°, where the electric lights are started at 2:30 on winter afternoons, are twelve hundred men mining iron ore for shipment to England, Germany and the United States. The daily output is about 9,000 tons; and it is shipped over a first-class modern railroad in steel ore cars about one hundred miles farther north to the harbor of Narvik on the Norwegian coast, already mentioned.

The amount of ore in the Kirunavaara has been repeatedly estimated; and each time the estimate is larger. When it is realized that this deposit of hard ore averages about 275 feet in thickness and is more than two miles in length, and rises in a mountain about eight hundred feet above the surrounding country, it may not be so difficult to believe that it contains approximately one billion tons of ore.

It is mined in open cuts or terraces; and the blasting can be heard for fifty miles. The annual output of ore now amounts to about three million tons. It is limited by the Government at present to 3,500,000 tons. The Swedish Government not only owns one-half of the stock of the operating company, but has an option to purchase the remaining half at an agreed price in about twenty-three years' time.

There is material for an evening's lecture in this mine alone, and there is only time now for a brief mention of it and its salient features. Although attention had been repeatedly called to this mountain of iron by Laplanders and hunters returning from the far-away northern wilds, yet very little was known about it until the Swedish Geological Survey Party led by Dr. Lundbohm camped there and collected material for reports. The first time was in 1875 and the second in 1896. Situated about 145 kilometers north of the Arctic Circle, 300 kilometers from Lulea on the Baltic, and 170 kilometers from Narvik, the distance from Stockholm is 1413 kilometers, or about 850 miles.

The first work preparatory for mining was in 1898. In 1899 the railroad (owned by the Government) reached Kiruna, and in 1902 was built to Narvik. Shipments began in 1903 with a production of about 800,000 tons.

Kiruna is situated in a desolate country, uninhabited before mining began, and only periodically visited by the nomadic Laps, for hundreds of years the only dwellers in the district. The climate is severe, the yearly average temperature being about 37° Fah. Winter lasts from the first of October to the end of May, and the snowfall is heavy. Kiruna is now a well-built town of about 7800 inhabitants. An elctric railway carries the miners to the foot of the mountain, and covered tramways or inclines take them up to the working faces. Hitherto the work of quarrying the ore has not been attended by any unusual problems, but as depth increases and the amount of rock to be mined becomes more nearly equal to the tonnage of ore, there will be an opportunity for the display of engineering skill of a high order. The average dip of the ore is about 55° to the east, and the foot wall rock as well as the hanging is already being mined in considerable quantity.

The ore is massive and dry, and the rocks above and beneath are likewise solid and fresh crystalline rock. Hence, the ground stands well and only an occasional pillar is needed even in large excavations.

The grade of the ore is high. Indeed, the Swedish ores constitute one of the most important sources of high-grade iron ore in sight today. The chief impurity is phosphorus in the form of apatite. This, however is so plentiful that instead of being detrimental it becomes an important asset. By the use of the Thomas-Gilchrist process the phosphorus is saved and converted into phosphoric fertilizer. Indeed, the Germans pay about as much for a unit of phosphorus as for a unit of iron. In this respect again we would do well to take a lesson from European practice. There is no one material resource at once so valuable and necessary and so scarce as phosphorus. I am inclined to the opinion that our phosphate products should all be by law retained within our own borders; and that we should avail ourselves of the opportunity to buy and utilize more of these Swedish high phosphorus ores. At present our seaboard iron furnaces import from Kiruna a certain grade of low-phosphorus, high-in-iron ores. The ore thus far produced from this Arctic Circle mine has averaged as follows :

Grade	A	1,141,302	tons	Average	69.63	Fe	0.024	Phos
	B	67,387	"	"	69.25	"	0.67	"
	C	371,854	"	"	68.60	"	0.162	"
	D	7,003,158	"	"	62.48	"	1.88	"
	F	278,966	"	"	59.34	"	2.78	"
	G	708,636	"	"	57.77	"	3.09	"

The amount of titanic acid in the ores is generally less than 0.5%; and the sulphur averages 0.05 or less.

But little is known concerning the geological age of the Kiruna ore and the surrounding sedimentary and igneous rocks. They are presumed to be pre-cambrian and post-archean. The geology of the ore deposits is complex and most interesting, and has been made the subject of careful study by Lundbohm and Geijer.

It is a remarkable fact that the great ore bodies of Kirunavaara and Luossavaara, (which lies a mile or two farther north, almost in line of strike), occur between two beds of porphyries of rather similar composition. The foot wall consists of syenitic rocks with a silica percentage of about 60, the hanging wall of quartz porphyries with about 70% silica.

The quartz porphyry is interwoven with innumerable dikes of finely crystalline apatite, generally small, but sometimes more than one meter in thickness. These dikes are often rich in magnetite and hematite. They also often contain much tourmaline and sometimes quartz and albite and show flow structures and orientated intergrowths. The quartz porphyry on the eastern side of the ore also contains numerous fragments of magnetite similar to that of the iron mountains. No dikes of magnetite are found cutting the quartz porphyry; but many intersect the syenite on the west. The contact between ore and country rock is generally sharp and distinct. The ore consists chiefly of magnetite; but contains hematite in small irregular lumps, in isolated crystals and in small veinlets. The ore is sometimes laminated and intimately banded with alternating layers of apatite. Some geologists have mistaken this structure for evidences of sedimentary origin.

According to the two main theories, this ore is either pneumatolytic-hydrothermal or magmatic. It occurs in a series of bedded eruptives; is younger than the underlying syenite porphyry and older than the overlying quartz porphyry. It was, therefore, formed either by gaseous emanations from the older rocks during an interval or pause in the outpouring of solid eruptive matter or is an actual eruptive sheet or dike of magnetite from an acid magma. In either case it is a deposit of rare type and phenomenal importance

Near the southern border of Lapland is still one more important iron ore district. This is at Gellivare. Iron ore was mined here in the 18th century, being transported by reindeer to small blast furnaces in the vicinity. It was only the invention of the Thomas-Gilchrist process which finally created a demand for these high phosphorus ores. The production is now about 1,200,000 tons annually. The production to date is about sixteen million tons; and the total estimated tonnage about 270,000,000. The ore is shipped during the summer to Luleå and goes chiefly to Westphalia and to Silesia; some of it also goes to England and America. The Swedish Government is a partner in the enterprise and the output is limited to about the present amount.

The geology is even more difficult than at Kiruna, because the rocks are more metamorphosed. It is apparent, however, that they were syenites and syenite porphyries originally, now recrystallized and granulitic or gneissoid. Apatite and titanite are abundant and there is plenty of quartz. Sillimanite and corundum are also present. There are dikes of metabasites, granites and pegmatites. The granite and pegmatite dikes frequently intersect the ore masses. Skarn breccias are also numerous, presenting in many instances striking structural and mineralogical similarities to the skarns of central Sweden.

The magnetic ore varies from 62% to 69% in iron and from 0.013 to 5% in phosphorus. Structurally the ore is hard and granular; and there is a parallel banding or striping due to the arrangement of the apatite.

The main ore belt has a length of about two and a half miles.

The ore is in irregularly shaped lenses or bodies, rising above the general level and even above timber line at this northern latitude.

Mining methods are modern and economical; and the adaptability and progress of the Swedish people everywhere evident is nowhere more strikingly exhibited.

An illustration of their keen interest in the subject of natural resources and iron ores in particular is afforded by the monumental work upon the iron ore resources of the world prepared by the Swedish members of the International Geological Congress and published in Stockholm in time for this meeting. This series of monographs in two quarto volumes with an atlas volume, represents the world's combined knowledge of the extent of the iron ores of all countries. Written largely in the English language, but also partly in German and French, it is the most elaborate statement of the subject ever heretofore prepared. It is not the work of one man, but of specialists in many parts of the world, all contributing their best data for enlarging the information of the people of the world upon a subject of vital importance. Although there is not sufficient time for me to review this publication, attention should be called to it as one of the most valuable of the products of the Congress.

Many other mines and localities interesting geologically have not been mentioned. An evening could be devoted to a description of the government method of owning and operating railroads in Sweden. Another lecture could be given upon the subject of water and electric power development and the progress and hope for the futur in the electrical metallurgy of iron and steel. Still other discourses could be devoted to the scenery, to the customs and costumes of the people, to their native industries and their accomplishments in music, painting, sculpture and literature. And after presenting a picture or description of all these, and more, there would still be so much untold that it would be necessary for you to go and see for yourselves,—and this I can in all sincerity recommend,—for, surely, nowhere within the bounds of civilization can be found warmer hospitality, truer friendship or gentler courtesy than among our flaxen-haired cousins of the far North, the Swedes.

THE IRON ORE RANGES OF MINNESOTA, AND THEIR DIFFERENCES.

N. H. Winchell, late State Geologist of Minnesota.*

1. There are two great iron-bearing formations.

When in the forties of the last century, iron ore was discovered at Marquette, in the state of Michigan, nothing was known of the relations it might have with the rocks in which it occurred, nor of the rocks with each other. Neither the state geologist, Dr. Douglass Houghton, nor the United States geologists, Foster and Whitney, paid much attention to the structural geology of the region. Indeed, it was one of the tenets of the famous report of Foster and Whitney that the "Azoic" was not susceptible of classification, nor of subdivision, so far as it appeared on the south side of lake Superior, and this idea was not dispelled until the region was examined by the later state surveys of Michigan and Wisconsin, and by the geologists of the United States Geological Survey. Several of the field geologists passed over the critical stratigraphic exposures without comprehending their significance. Dr. Rominger, of the Michigan survey, called attention to some non-conformities at Marquette which would have led him to discover the duplicate nature of the iron-bearing rocks if he had sufficiently appreciated their significance. Foster and Whitney in making a survey of the iron district of Michigan, also Irving for the later United States Geological Survey, and Brooks for the Michigan State Survey, believed that not only the rocks were in one great "azoic" series, but that the iron ore was confined to one horizon. If they saw conglomerates, great conglomerates such as are now universally recognized as basal beds which indicate non-conformities, (and some of them did see them) they either believed them to be local breccias caused by igneous outbreaks of granite or dioryte, or put them along with the ore into the same formation.

It was only after some examination of the geology of northeastern Minnesota by the members of the Minnesota Geological Survey that it was learned that, at least so far as concerns the state of Minnesota, the iron ores are not all in the same formation. We found that the rocks that contain the ore at Soudan are much older than those that carry the Mesabi ore. We found that the Mesabi rocks, which are the younger, run in a diverging course, from the line of strike of the rocks that carry the Vermilion ore. Spurred by this discovery, we organized a small party and visited Marquette, where the greatest development had been made. We also examined the Penokee-Gogebic rocks, in Wisconsin, and without going now into the details so far as those iron regions are concerned, we concluded, not only that on the south side of lake Superior there were two different ore horizons, but that at Marquette they were both to be seen easily in the mines that were being exploited. The first formal announcement of this important generalization* which ever was published was made in the sixteenth annual report, 1887, of the Minnesota survey, pp. 43-47. It was amplified in the seventeenth, 1888, pp. 43-45, and, when the priority of our discovery was questioned by some of the Wisconsin geologists, it was defended in the twenty-first annual report, 1892, pp. 87-99. It was very soon recognized as an important fundamental datum in all research work in the geology of the Lake Superior region. It is the starting point in all intelligent exploration, for it is very evident that unless the exploring geologist knows how the strata run, and what their position with respect to the ore which he is to search for, he is very liable to expend a large sum of money by working in the dark.

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*The paper was given February 22, 1911, as a public address at Aitkin, and subsequently at the May meeting of the Academy of Science. The figures were shown on a screen by stereopticon.

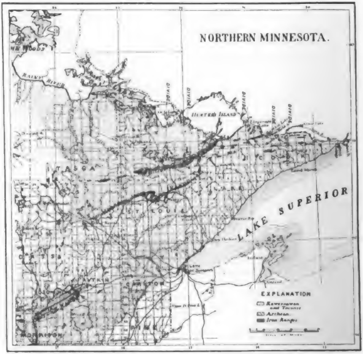
NORTHERN MINNESOTA.
RAINY RIVER
HUNTERS ISLAND
DIVIDE
ITASCA
ST. LOUIS
LAKE
COOK
CASS
AITKIN
CARLTON
PINE
MORRISON
LAKE SUPERIOR
EXPLANATION
Keweenawan and Taconic
Archean
Iron Ranges

Fig. 1.—Location of the iron ranges of Minnesota.

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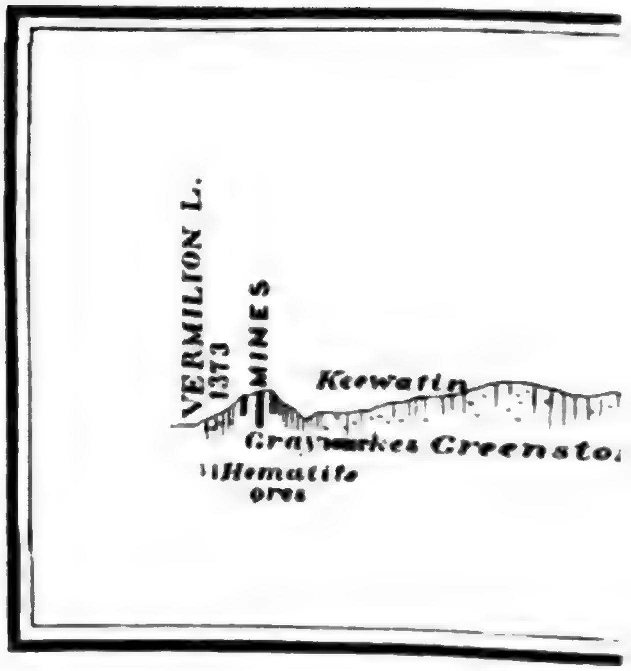
*The initial dissent from the idea of the "Huronian" age of all the ores of the Lake Superior region was published in the thirteenth report of the Minnesota survey, pp. 24-37, 1884.

cluded not only that on the south side of [illegible]


VERMILION L.
1373
MINES
Keewatin
Graywackes
Greensto
Hematite ores

2. Differences of Geographic Location.

In order that this great difference in the stratigraphic relations of the great iron-bearing formations may be fairly understood I will illustrate it by a few lantern views.

(1) Northern Minnesota, showing the areas of the Keweenawan and Taconic, and of the Archaean; also the geographic positions of the Vermilion and Mesabi iron ranges. This view is taken from the Collections of the Minnesota Historical Society, Vol. VIII, paper read January 21, 1895. The rocks of the Vermilion range extend westwardly a great distance. The indication on the map shows only where they have been seen, and especially where they have been known to carry more or less ore like that at Soudan. These rocks are not simple, but complex, and yet they have some general characters in all areas in which they are uniform, and by which they can always be distinguished from the rocks of the Mesabi range. For our present purposes these are the only formations which it is necessary to consider—two great non-conformable formations separated by what has been called by Lawson "the great eparchaean interval."

(2) A section of the rocks extending from Soudan near Vermilion lake, southward under lake Superior to the Penokee range at Penokee gap, showing the dip of the different formations. Here are the Archean rocks at Tower, or Soudan, standing vertical, disappearing under the rocks of the Mesabi range and reappearing on the south side of the lake still maintaining their vertical attitude It is these rocks that hold the ores of the Vermilion range. Overlying these vertical strata are the gently dipping strata that carry the Mesabi ores, and above them are the trap rocks, gabbro, sandstones and shales that compose the great Keweenawan formation which on Keweenaw point are famed for the metallic copper which they have furnished. The Mesabi rocks and the copper-bearing rocks agree essentially in dip, and are closely related in age. This diagram is taken from the sixth bulletin of the Minnesota survey, "The Iron Ores of Minnesota," published before the great working of the Mesabi range and cotemporary with the first discovery of merchantable ore on that range. This non-conformity extends, so far as has been observed, throughout the whole Lake Superior region, all over Canada and New York and New England. This remarkable fact has great significance, nothing less than the date of separation between two great world epochs.

3. Structure of the Vermilion Range Rocks.

If we inquire now how these formations can be distinguished, we enter upon the actual problems that confront the geologist, both in the field and in the laboratory. It is not possible to give the detailed differences nor the steps by which these differences have been determined. Suffice it to state that the main result was reached after long field examination and mapping, and after minute examination of the mineralogic characters. Before arriving at that stage in the research where we were qualified to give reliably the conclusions of our labor, we had spent 21 years on the investigation, and had minutely examined 1000 microscopic thin sections of rocks gathered in the course of the survey. What I shall give you will be the merest skeleton, and will embrace only some of the most tangible features. If you wish for more detail you may examine the reports of the Minnesota survey, especially volumes four and five of the final report.

I have already stated that the rocks of the two series are distinguished by their different geographic area and by their contrasting stratigraphic attitude. But they are also different in their composition and internal structure.

I will show you a few lantern slides that portray the internal structural relations, first, of the rocks of the Vermilion iron range, and of their associated strata. The Vermilion ore is in the bottom of the Archean, the oldest rocks known in the state, and in the entire Lake Superior region. If they were horizontal, as they must have been originally, they have been compressed horizontally and folded upon themselves, backward and forward, so as to be repeated perhaps several times in any section that might be observed in traveling across the folds.

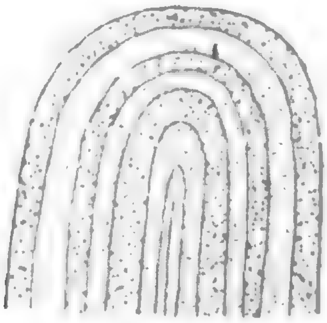


Fig. 3.—Folded Archean Strata.

(3) This slide exhibits the top of a fold actually observed in Minnesota, near Burntside lake. If the top of this lot of folded strata were to be cut off horizontally, as we know all the Archean strata have been by the waste of time, and especially by the abrasion of the Glacial epoch, there would be a series of beds standing vertical, running parallel in belts of outcrop, differing from each other in orderly variations from the center of the fold in opposite directions. It is only where the rocks are bare over large areas that the identity of strata on opposite sides of such a fold can be traced out and proven, and very seldom has such a succession been proved.

In this folding and squeezing process changes were wrought in the mineralogical composition of the strata. Heat, derived partly from the friction and partly from the interior of the earth, produced chemical transformations, and new minerals resulted from such a metamorphism, and the sediments became crystalline, sometimes producing mica and hornblende schists and sometimes gneiss; and, if, in such plastic condition, these recrystalized materials were thrust by pressure into any of the cracks, or were extruded at the surface, they became granites of the various degrees of acidity, or sheets of lava. They formed dikes and bosses and all kinds of irregular masses. If they cooled and solidified without being moved from their places they formed gneiss, which is for the most part simply a sedimentary rock re-crystallized where it was first deposited.

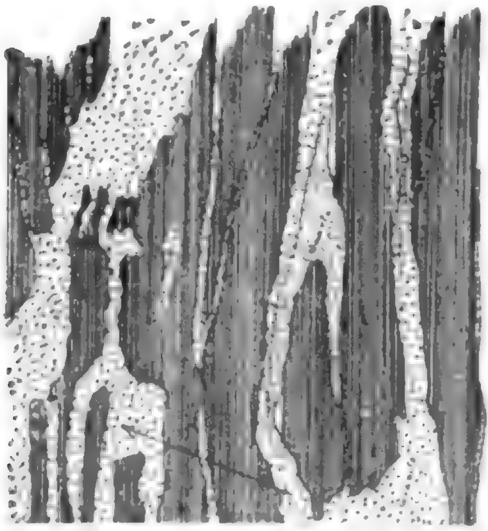


Fig. 4.—Mica schist intruded by granite.

(4) The next slide shows some of these recrystallized sedimentary rocks. The original sediments, represented now by the mica schist, were penetrated and crossed by granite in diagonal intrusions and in parallel laminations. This granite is not supposed to have come from a deep-seated source, but from some nearby locality where the original rocks were fused, or at least plastic so as to enter any cracks that were formed in the adjacent sediments.

This vertical attitude of the strata is seen at all the open mines in the Vermilion range. Here however the original rock was not an acid sedimentary one, but a basic igneous one. Outside of the mines, at short distances to the north or south, however, this igneous, basic, green rock is replaced by acid sediments. It is a very significant and remarkable fact that the ore of the Vermilion iron range is in a basic igneous formation, one which has been called "Kawishiwin", and that in some cases it is in somewhat regular alternation with layers of such igneous rock. We will not dwell here on the importance of that fact, but will pass at once to some slides that show that structure.

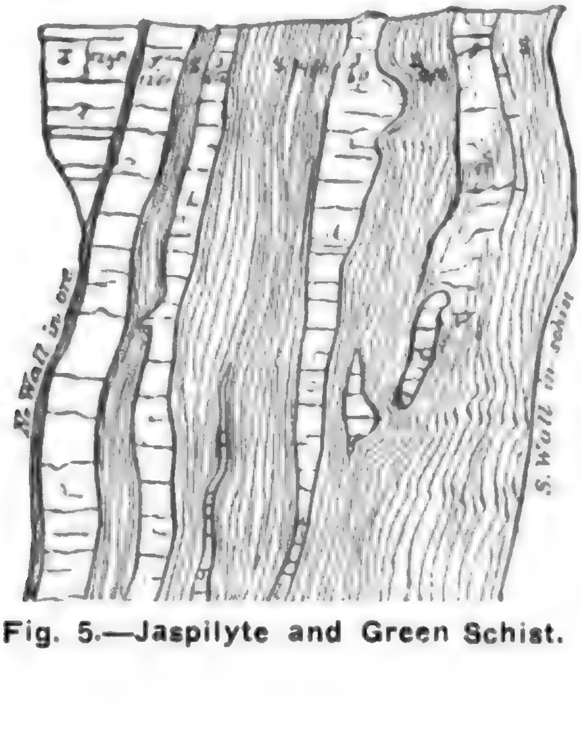


Fig. 5.—Jaspilyte and Green Schist.

(5) This slide shows the ore, which is also called jaspilyte when it is of low grade and distinctly banded by silica, alternating with green schist, both standing vertical.

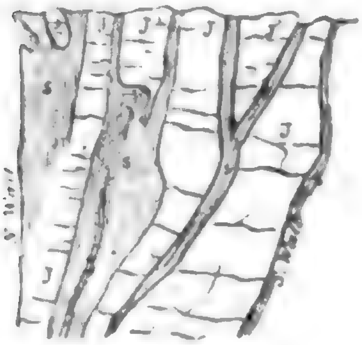


Fig. 6.—Jaspilyte and Green Schist.

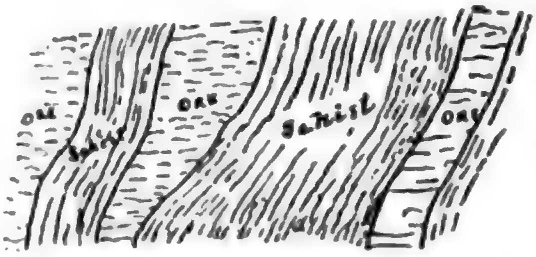


Fig. 7.—Ore and Green Schist

(6) This also shows the same structure. These were both seen in the mines at Soudan, in the early stages of the mining at that place, and could have been repeated many times at all the original openings.

(7) This is another illustration of the same fact. In short, in all the mines, whether at Soudan or at Ely, the grand structure is the same. There are minor irregularities due to later fracturing and displacement, but these can easily be seen to be local and of later date than the orignal stratification.

One singular structure was observed at the "Stone mine" at Soudan which was appealed to by Dr. M. E. Wadsworth to show that the jaspilyte is of igneous origin, viz., a so-called "dike" was seen to diverge from the main jaspilyte mass, and to cut somewhat diagonally across the green country rock. The place where this jaspilyte spur, which consisted largely of good hematite ore, entered the wall of the mine as it stood vertical, is shown by this slide. (Fig. 8).

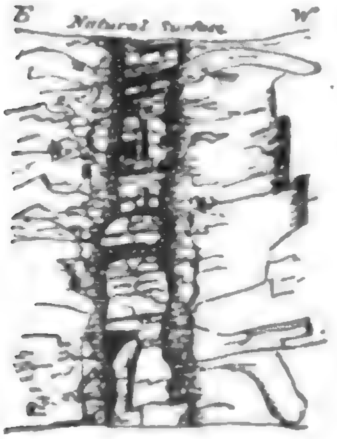


Fig. 8—So-Called Dike of Jaspilyte

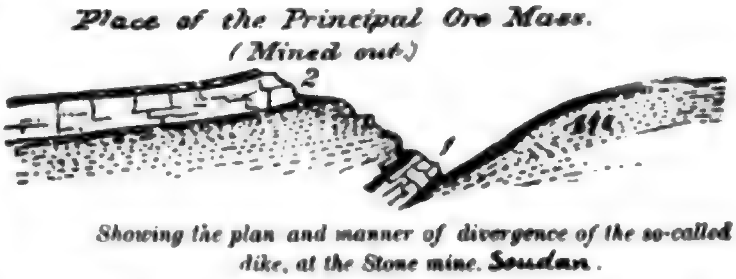

Place of the Principal Ore Mass.
(Mined out.)
2
1
Showing the plan and manner of divergence of the so-called dike, at the Stone mine. Soudan.

Fig. 9—Ground Plan of the So-called Dike.

(8) Which was a drawing made on the spot. As this spur, in its course, rose to the natural surface, its manner of divergence was visible and the surface plan of the divergence was evident and was also sketched as shown by the next slide. (Fig. 9).

(9) In the light of what we know now it is apparent that this diverging spur of jaspilyte is only the commencement of one of those separate ore masses which spring up (in section) in the midst

of the schist nonconformable with the schists in a manner already illustrated. Several others are illustrated by Dr. Wadsworth at Marquette. (Notes on the Geology of the Iron and Copper Districts of Lake Superior. Mus, Comp. Zool., Geol. Ser., Vol. 1, 1880.)

What is Jaspilyte?

Now let us go a little more into detail.

Anyone who has read the descriptions published in the Minnesota reports can not have failed to encounter the word "jaspilyte" a great many times. It will be well to dwell a few minutes on the question, What is jaspilyte? The view here seen, No. 10.

(10) Shows a characteristic exposure of this rock. It is the rock which first attracted the attention of the early explorers who were seeking iron ore. It forms the summits of the great ridges seen at Soudan and elsewhere. It is not always iron ore, but it contains in nearly all cases a considerable proportion of hematite ore. Indeed it becomes the iron ore of the Vermilion range by an increase in the percentage of hematite. The beautiful banding seen is formed by alternations of iron ore and silica. These bands are about an inch in width, but sometimes less than half an inch, or more than six inches. The silica is usually colored red, or purple, or almost black, with the presence of iron, or at least of iron ore, but sometimes is white. These alternating brightly colored bands form a handsome surface, and their beauty is very often enhanced by the manner in which they are bent and apparently twisted together.

As there are three conditions in which this jaspilyte is found in these knobs I wish to call your attention to a feature seen in this slide. Along the lower side you see a change in the direction and regularity of the bands. There is also a change in their composition. Some of the bands here consist of green chloritic material, and as this increases in receding from the main jaspilyte mass, so it grades into a green schist, and this schist is not easily distinguished from the green schist which, all about here, plays a great part in the composition of the country rock. This stratigraphic graduation from the alternating bands of jaspilyte into the green schist cannot always be seen at the contacts of the contorted jaspilyte upon the schist. But as it occurs in several places plainly, it shows identity of age and method of formation—at least for those parts that are thus interstratified. But care must be taken here to not include the entire jaspilyte mass in this inference, for it is just as plain that, even in the majority of cases the jaspilyte and the green schist had different origins although about cotemporary. The contorted bands of jaspilyte have frequently an abrupt and nonconformable contact on the green schist, or on the green stone in which it lies. This nonconformity is less evident in this view, but can be observed at the plane where the contortions cease and where the green element in the stratification begins to appear.* The only inference to be drawn from this is: that from some primary source, and from a greenstone as a source, contemporaneously two sorts of sediment were brought into the ocean and laid out in successive strata, according to the action of the ocean's currents. It can be shown satisfactorily that the silica of the jaspilyte in its primary masses was derived from chemical deposition and as the silica in these interstratified bands cannot be distinguished from that in the primary mass, it is necessary to allow that the silica in the inter

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* On the plate this plane is indicated by the two white stars.

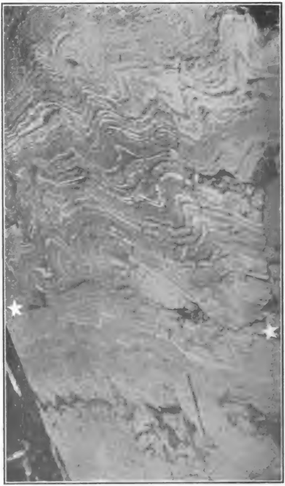


Fig. 10.—Characteristic Surface of Jaspilyte...Soudan.

stratified jaspilyte was also derived from chemical deposition. Whatever may have been the physical conditions that obtained when the silica of the primary masses was deposited it is plain that that which forms layers interstratified with fragmental material, was chemically precipitated from solution in the bottom of the ocean in which the sediments were accumulated. These fragmental sediments are not always simply green schist, but also may be darker and more slaty strata, and may even grade into various kinds of detrital rocks, but in all such cases the chemically precipitated silica is evidently present—though not always as distinct homogeneous bands. It is then apt to be disseminated as a binding material amongst the fragmental sediments, forming horn slates, fine graywackes, chert, and different very siliceous fine schists. We have then here two forms of jaspilyte, viz: that which is interstratified with green schist conformably, and that which is in masses nonconformable with the green schist, or with the greenstone of the region.

There is a third sort, and this third sort is usually found in immediate contiguity with the other sorts. It should, first, here be stated that the Archean is divided into two main parts, the Lower Keewatin and the Upper Keewatin, and that a great conglomerate is at the base of the Upper Keewatin. This great conglomerate is composed of debris, both coarse and fine, derived from the Lower Keewatin. The jaspilytes already described are in the Lower Keewatin, but the third sort is in the Upper Keewatin, and is found in connection with this great basal conglomerate. Indeed, it is simply a débris derived from the other two sorts, and it is stratified as fragmental sediment in the midst of other sediments, evidently in the waters of a widespread ocean. It is not pure and clean. It does not form bands of the kind seen in the Lower Keewatin, but its pieces mingle in sedimentary strata with other pieces so as to make grits, graywackes and quartzytes, and to grade in fineness so as to be integral parts of some schists and slates. Considering only the quartz, each individual unit of the sediment is not a simple quartz grain but a grain of jaspilyte consisting perhaps of many microscopic quartzes. While the other two sorts may be called primary jaspilyte, this sort is certainly a secondary jaspilyte. This secondary jaspilyte is seen in this view.

(11) Secondary jaspilyte. It so happens that at the place where this photograph was taken the rock has been pressed and sheared so that all the parts are elongated in the same direction. On the south slope of the west range of the two jaspilyte ridges at Tower this secondary form of jaspilyte is seen well exposed all along the southern side of the hill; and some of the detached masses are very large. They form a part of the great conglomerate which constitutes the base of the Upper Keewatin.

5. **The rocks of the Vermilion range.**

After this particular description of the jaspilyte of the Vermilion range, it is necessary only to glance at the rocks themselves that constitute the formation in which the ore is embraced.

FIRST, and most conspicuous and important is a great basic greenstone, which shows all the characters of an old igneous rock. It is not a debris. It is not stratified, but massive. It extends northeasterly to near Gunflint lake, where it seems to sink away and granite takes its place. It forms the highest hills of the Giant's range of mountains, south of Ogishke Muncie lake.

SECONDLY, there is a large amount of stratified green schist,

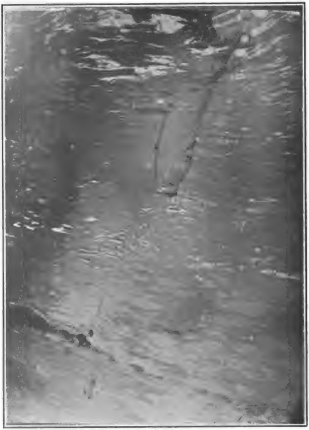


Fig. 11.—Secondary Jaspilyte. Upper Keewatin, Tower.

evidently derived as a debris from the great greenstone. The strata of this schist stand nearly vertical, but non-conformable on the greenstone just mentioned.

THIRDLY, A great series of other fragmental rocks, some very fine and some coarse. Many of these strata can be called graywacke, and many others are as fine as slate, and even as flint. These sediments sometimes appear like quartz porphyry.

While these are the principal types of the rocks in this formation, they are not always distinct and plainly characterized, but they grade into each other with all conceivable intermixtures. Sometimes the green schist element in the form of chlorite is mixed with the graywackes, or comprises a large proportion of them. Such a rock has been called "greenwacke." Sometimes the green schist is permeated by fine chemical, yet granular, quartz. Sometimes the chloritic element in the schist is rather micaceous, with a silky luster, but having still a light green tint. Sometimes the whole formation is converted to a metamorphic rock, forming mica schist, gneiss, hornblende schist and related rocks. This condition usually extends to the formation of granite, syenyte, dioryte and a number of massive igneous rocks, which are seen to penetrate the original rocks as dikes. When the greenstone itself is thus affected by metamorphism and fusion it seems to have given rise to diabase and gabbro, which also can be seen to pierce the original rocks in all directions and which sometimes overflowed at the surface, forming traps.

Now this eries of rocks with their variations, as a whole, cannot be found outside of the Archean. They cannot be found in the Mesabi formation.

6. The Vermilion range ore.

If we note specially the ore of the Vermilion range, we are at once impressed with the fact that it is a "hard" ore. This is exhibited at Soudan, its chief impurity being quartz. It is a characteristic red hematite. The ore at Ely, as exhibited at the Chandler mine, you may consider an exception, as it was called a "soft" ore. But it is no exception. It was at first in the form of hard jaspilyte as at Soudan. It had been crushed into small pieces, but each piece was hard as the Soudan ore. This shattered condition of the Chandler ore was due, probably, to movements of the earth's crust, caused by earthquakes. It is to be remembered that an enormous lapse of time passed between the formation of the ore and the close of the great Keweenawan age, and that during the Keweenawan age northern Minnesota was convulsed by the most profound earthquakes and by volcanic action.

7. Two parts in the Archean.

I have mentioned already the division of the Archean into two parts, the Lower Keewatin and the Upper Keewatin, and the existence of jaspilyte also in the upper member. These two great parts are entirely similar in composition and in posé, but they are separated by a great conglomerate, the Ogishke conglomerate, which belongs in the basal part of the Upper Keewatin and marks a great nonconformity between the two parts. Aside from the existence of this great conglomerate, it seems as if the processes of rock-making continued the same from the Lower Keewatin through the Upper Keewatin. What may have been the cause of this great conglomerate is entirely problematical, but it has been suggested by Prof. Coleman that it is of the nature of a glacial moraine, which, if true, would carry glaciation back almost to the commencement of geological time.

8. The Mesabi Iron Range.

I have now described in a very synoptical and incomplete manner the Vermilion Iron range, its rocks and its ore. We turn now to the Mesabi range. It is my purpose to show you the great differences between these ranges. We do not have to study the Mesabi range very long before we learn that its rocks are younger than the rocks of the Vermilion range, and that they lie nonconformably on the vertical strata of the Vermilion range, and almost in a horizontal attitude. This was illustrated in the section shown, extending from Tower southward to the Gogebic range in Wisconsin, and will be illustrated by several views that are to follow.

(12) At the Mahoning mine at Hibbing this photograph was taken, about three years ago. It shows the north wall of the great pit, consisting of hematite ore in thin strata. Notice the irregular knotty structure of the thin strata. There is no sharp transition between the ore and the rock, like that in the Vermilion range, but the rock itself changes into ore, and the steam shovel shifts its direction only when the grade of the ore is too low. Both ore and rock are so soft that for the most part they can both be excavated without blasting, though sometimes the ore is first shattered by a powder blast. The steam shovel is then sufficient.

Fig. 12—Structure of the Mesabi Ore at Hibbing.

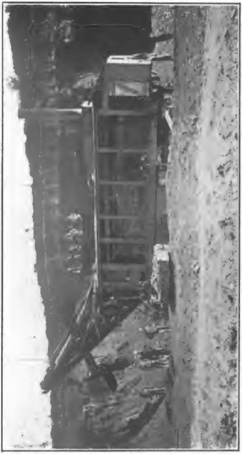


Fig. 13—Steam Shovel at Mountain Iron Mine.

(13) Here you see the steam shovel at work, at the Mountain Iron mine. From the mine the ore is dumped immediately onto a railroad train.

(14) This is a profile section showing the Mesabi ore and its rocks lying upon the greenstone which is the prevailing rock of the Vermilion range.

(15) This shows the same, but here the massive greenstone of the Vermilion is replaced by green schist and gneiss. The quartzyte seen at the bottom of the profile is the lowermost rock of the Mesabi range.

(16) This is a section drawn from nature, illustrating the conditions at the Mountain Iron mine when the ore was first discovered. The outcrop of rock at the left attracted attention and was explored by more or less excavation. It showed some iron ore, and was believed to be a "capping," so-called, of a bed of ore. But no good ore was found in it nor about it. Then a test pit was sunk, at some distance toward the south. This pit struck rich, soft hemetite ore, which, on being drifted toward the north showed that it was underlain by quartzyte, and also, later, was found to grade insensibly into a rock, here shown in outcrep, which was called taconyte.

(17) The relation of the ore to this taconyte was for some time a great puzzle. The ore was found overlying it, and underlying it, and sometimes the ore was found to be embraced within the taconyte, in pockets and large lenses, as seen in this profile section. It required long and careful study of numerous pits, and of the mines that were later opened, to prove conclusively that the ore was produced by an alteration of some rock, of which the taconyte was its present representative.

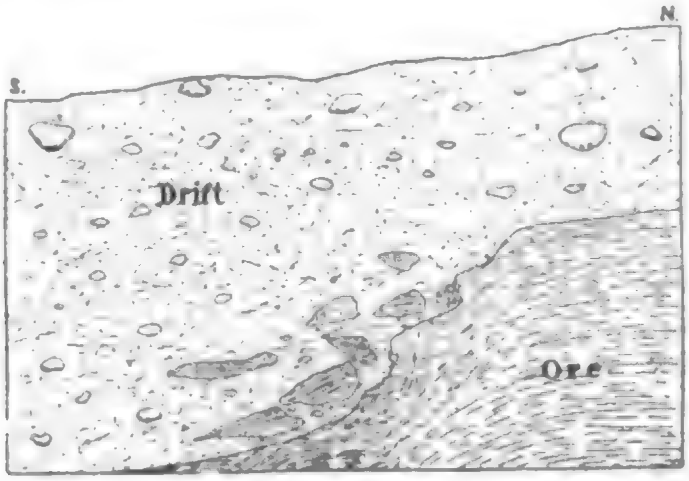


Fig. 18—Mesabi Ore Disseminated in the Drift.

(18) This view shows the manner in which the ore is broken down and disseminated in the drift of the region.

9. The Rocks of the Mesabi Iron Range.

If the two ranges differ in geographic location, and in the attitude of the strata, and in the nature of the ore which they respectively contain, yet the most striking feature of the Mesabi rocks is their simplicity and uniformity of composition, as contrasted with the complexity of the rocks of the Vermilion range. If the taconyte

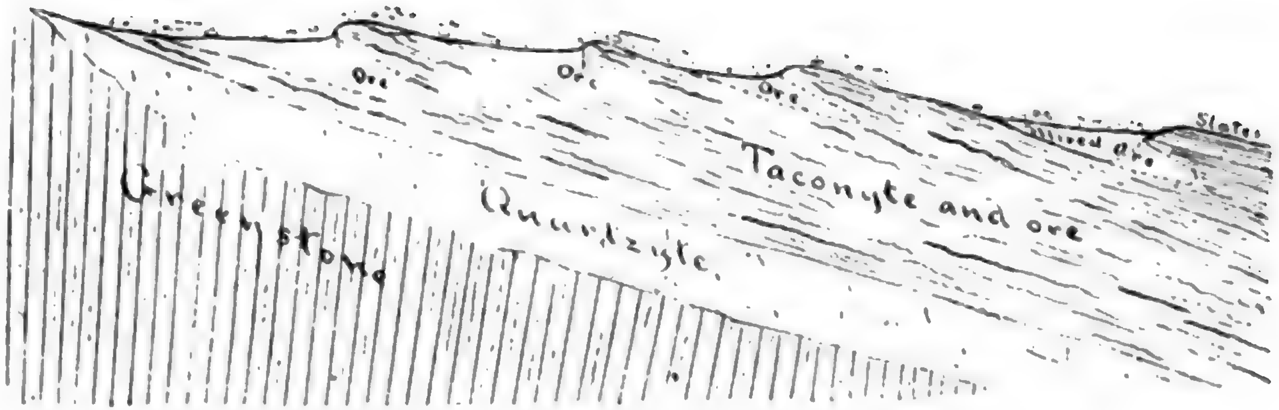
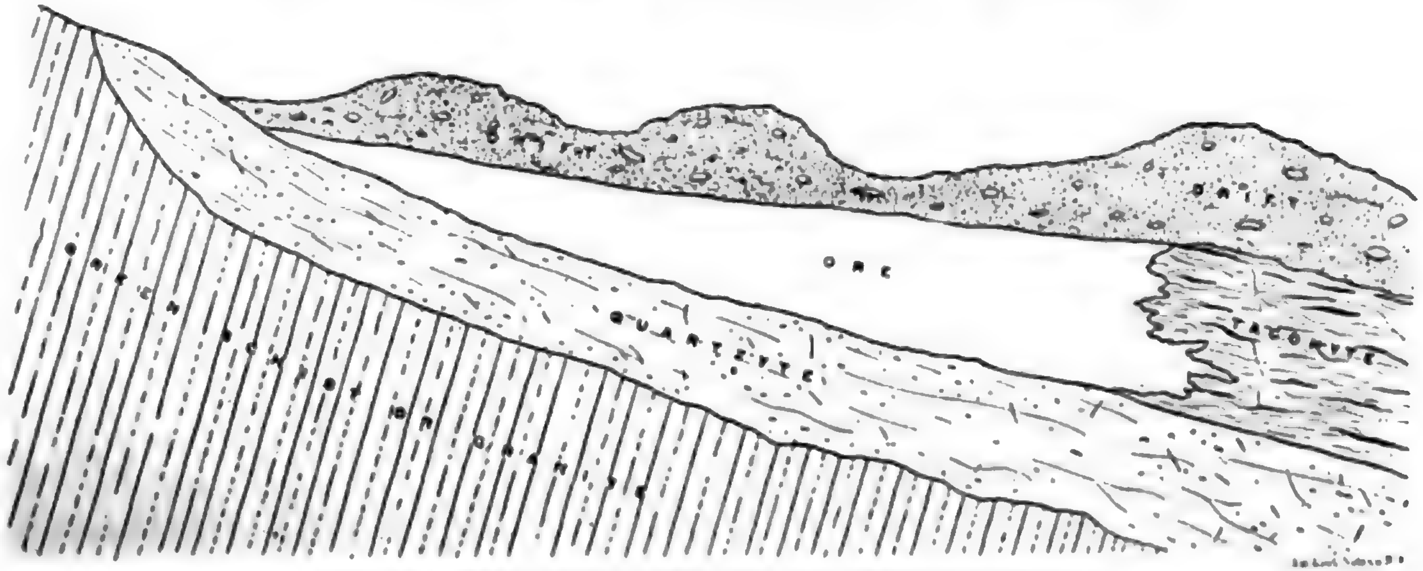

Ore
Ore
Ore
Altered ore
Slates
Taconyte and ore
Quartzyte
Greenstone

Fig. 14—Mesabi Rocks Nonconformable on the Archean.


Drift
Drift
Ore
Quartzyte
Taconyte
Green schist or granite

Usual Occurrence of Ore below Drift and resting on Quartzyte

Fig. 15. Mesabi Rocks Nonconformable on Schist and Granite of the Archean.

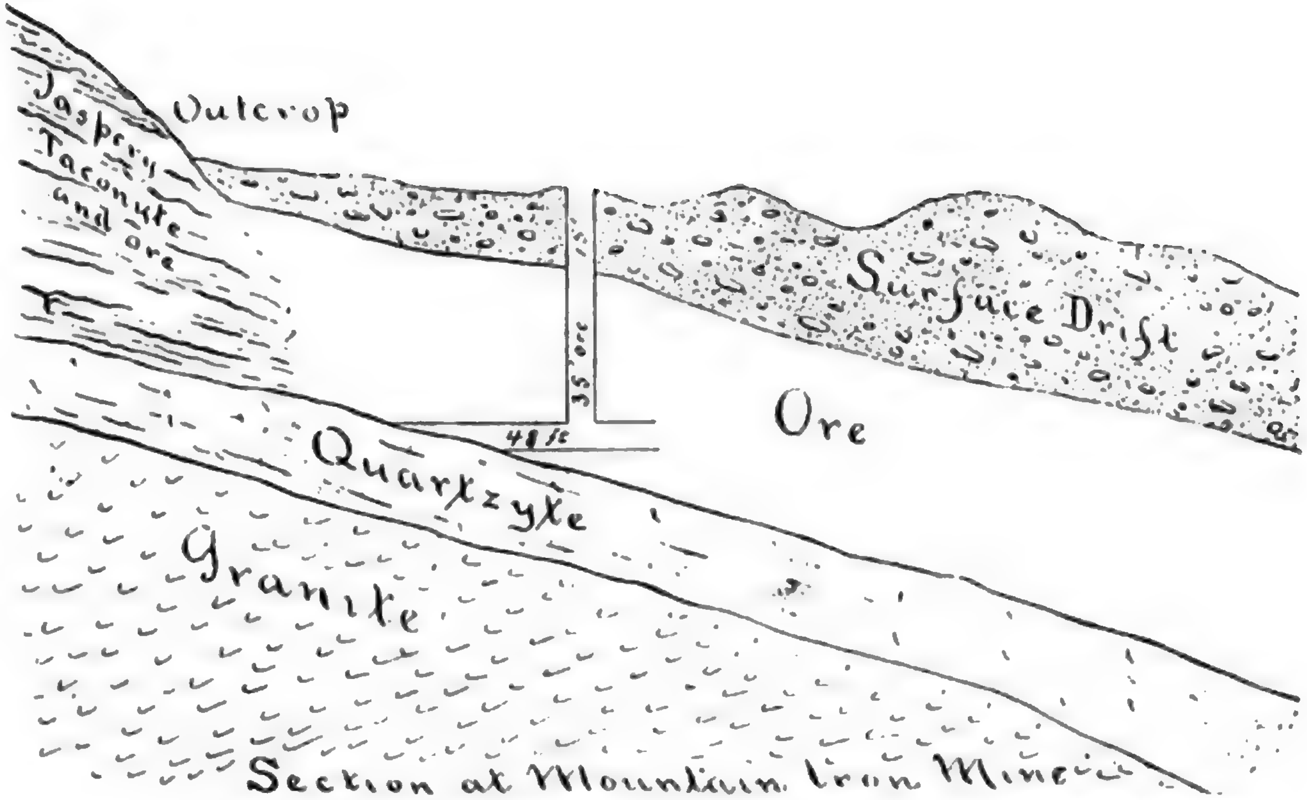
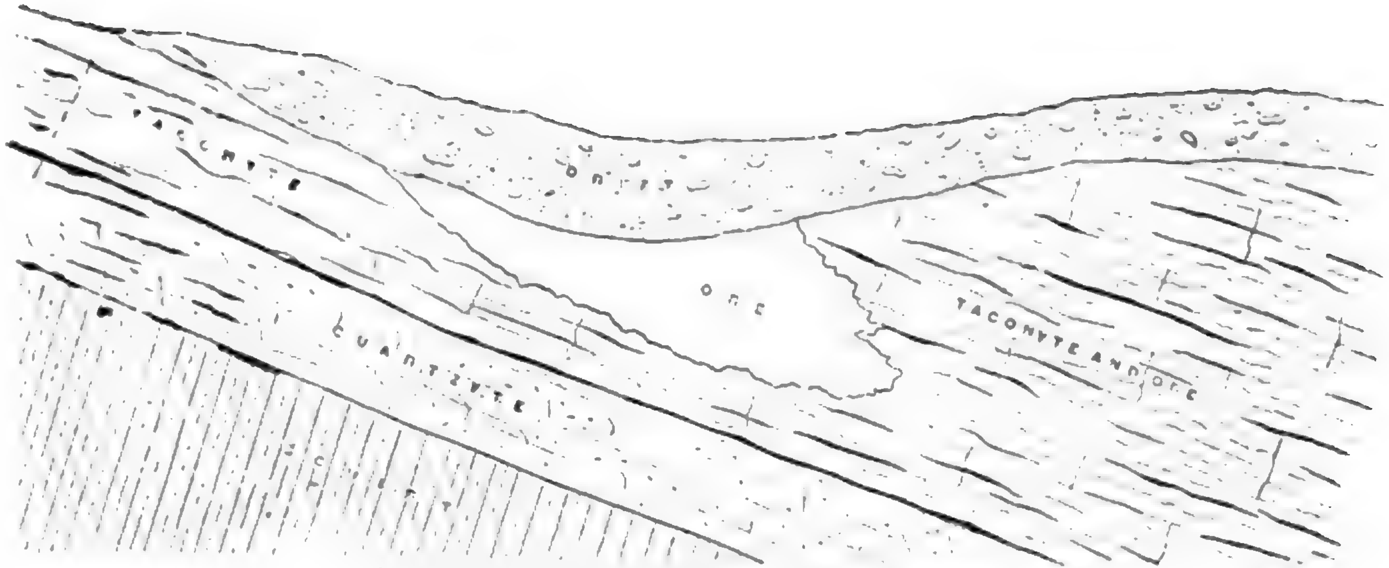

Outcrop
Jaspery Taconyte and ore
Surface Drift
35 ore
48 ft
Ore
Quartzyte
Granite
Section at Mountain Iron Mine

Fig. 16—Ore, Taconyte and Quartzyte of the Mesabi Nonconformable Over Granite.


TACONYTE
DRIFT
ORE
TACONYTE AND ORE
QUARTZITE

POSSIBLE METHOD OF OCCURRENCE OF ORE ON TACONYTE

Fig. 17—Ore Embraced within Taconyte.

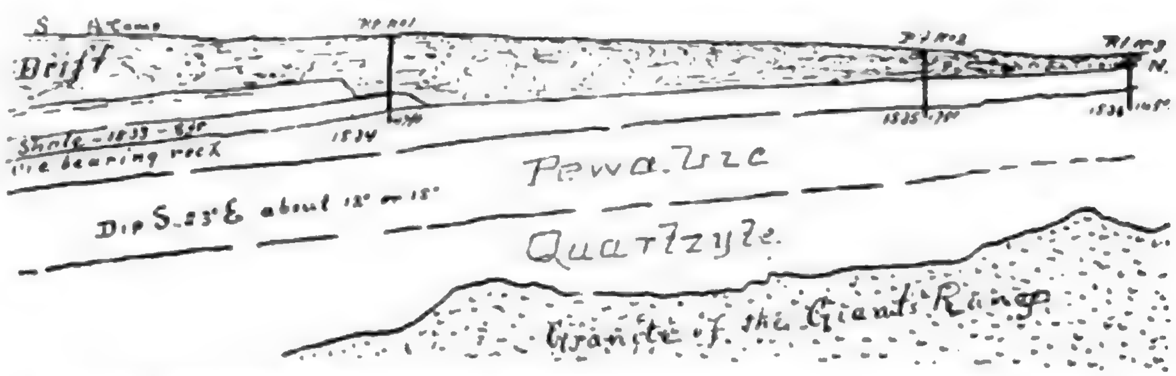

S.
Drift
Shale
ore bearing rock
1534
1535
1536
N.
Pewabic
Quartzite
Dip S. 23° E about 12° or 15°
Granite of the Giants Range

Fig. 19—Showing Red Shale Lying Above the Ore at the Diamond Mine

be considered simply a phase of the iron ore, there are but two rocks in the entire series of the Mesabi section, viz: quartzyte and slate. By instituting minute distinctions certain varietes of these two might be called different rocks. For instance, the quartzyte, which is at the bottom, is sometimes a conglomerate, and the slate which is usually dark colored or even black, is sometimes purplish, or even red, and so soft as to be more correctly called a red shale, or paint rock.

The significance of this red shale has but lately been understood, and even its existence was overlooked. It was first seen by the writer at the west end of the Mesabi range where it was penetrated to the depth of eight feet and was found lying on ore-bearing rock, the latter resting on the well-known basal quartzyte. This was in 1888, and the diagram published at the time, in his seventeenth report, is seen in the following slide.

(19) Section at the Diamond mine at the west end of the Mesabi range, showing red shale lying above the ore.

A similar red shale can be seen at the east end of the Mahoning mine, at Hibbing, where it lies at a stratigraphic horizon which furnished a large amount of ore at a short distance further west, in the pit of the great mine. This red shale cannot be distinguished from the red shale of the Keweenawan seen at many places along the shore of lake Superior, and in the lower valley of the St. Louis river near Fond du Lac.

10. The Pecularities of the Mesabi Ore.

Without dwelling on the significance of this red shale, at this time, we will now briefly notice the Mesabi ore itself. After what has been stated as to the easy mining methods, it is hardly necessary to say that it is a soft granular ore. If we inspect it closer we find that the granules sometimes are made of concentric concretionary shells. Some of them are roundish, and some are parts of spheres that have been broken. Sometimes these spheres are much increased in size, and are then not concretionary. They are shaped like pebbles, evidently water worn, and they are in such numbers that they form thick beds of conglomerate. As they still consist entirely of hematite such conglomerate beds have been extensively mined by the use of the steam shovel. This is particularly true at the Mountain Iron mine, where the bed of conglomerate is at least a hundred feet thick. It is to be inferred from this gradation that the fine and the coarse were from the same source, and have suffered a similar history—in other words, that they have both resulted from an identical change to hematite from some earlier condition of the parent rock.

It is not warrantable here to rehearse the steps of the long research through which this investigation has been carried—having for its end the proper answer to the question—What was the nature of the original rock the alteration of which produced the Mesabi iron ore? In other words, what was the origin of the Mesabi ore?

1. Igneous Rock in the Mesabi Range.

Near the close of the late Minnesota survey it was found, at the east end of the Mesabi range, at Gunflint lake, that the Mesabi rocks contained a considerable amount of volcanic elements. Some of this volcanic element was in the form of ragged and rough pieces of volcanic breccia mainly changed to flinty and jasperoid rock, and some was yet glass—an old volcanic glass. As the study progressed, it was found that such volcanic glass was the main constituent in the Mesabi at the west end of the range, really composing the bulk of the so-called black slate. It was found that this volcanic material had been rapidly accumulated, but that much of it was in the form of sand, more or less rounded by friction. It was found that this volcanic sand had suffered alteration, at the horizon where the ores exist in abundance, and by chemical changes and transportion underground, had given rise to various new minerals. These new minerals were sometimes crowded together in the strata, and sometimes were gathered in large amount in places by themselves, and composed strata of considerable thickness. These minerals are:—hematite, quartz, calcite, kaolin.

The hematite, it is needless to say, is the soft ore of the Mesabi range. The quartz is the fine granular silica which has been called (incorrectly) chalcedonic quartz. The calcite is that which, in rare cases, constitutes thin and lenticular beds of limestone. The kaolin is found also to constitute beds, several feet in thickness. Now I have not mentioned several minor minerals such as actinolite, sphene, mica, which are in microscopic amounts, but they ought to be mentioned because they are characteristically produced by the alteration of basic igneous rock.

I have omitted, also, to mention another important product of this alteration, viz: a green, rather soft, substance which has been named greensand and greenalite.

This igneous character of the original rocks of the Mesabi range has recently been discussed anew in the "Proceedings of the Lake Superior Mining Institute." Some of the characteristic outward aspects of this rock will be shown.

(20) The basaltic jointage seen in the rock cut by the railroad in the approach to the Oliver mine. Nothing but the cooling of heated rocks is known to produce such a jointage. It can be seen in any place where massive igneous rock has been allowed to cool. It sometimes occurs also in non-igneous rocks that have been heated by contact on igneous rocks, as in the conglomerate of Ogishke Muncie where affected by intrusive granite. This is an infallible sign of great heat and slow cooling.

(21) As the igneous rocks of the Mesabi range were largely of the nature of surface lava, so several of the structures of trap rock have been observed. This view gives an illustration of the structure known as "ropy structure." When a mass of liquid lava has become cooled so as to be covered by a thin scum or skin, if the molten part continues to move this skin of semi-cooled lava crumples up on the surface in the same manner as the crumpling of cream at the edge of a pan as the milk flows out from under it. Such a crumpled mass of trap may be several inches in thickness. The view shows a small fragment.

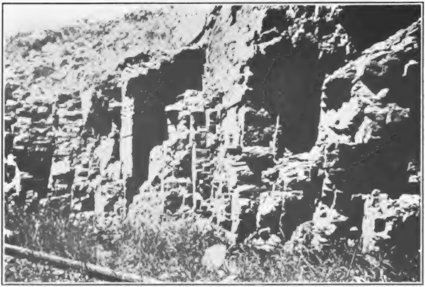


Fig. 20—Railway Cut in Approach to the Oliver Mine, Virginia. (After Leith)

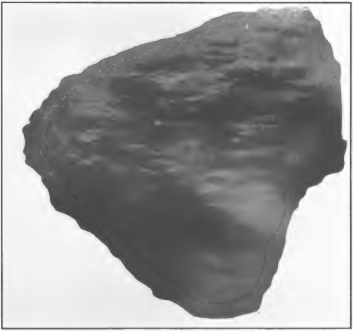


Fig. 21—Ropy Structure Seen in the Mesabi Ore.

[illegible]

[illegible] igneous rocks of the [illegible] illustrates the [illegible] of the mining [illegible] adjoining mine. The [illegible] igneous rock is [illegible]

[illegible] been described in [illegible] used to have [illegible] characteristic of lava, [illegible] Lake Superior shore.

[illegible]

[illegible] the most indispen[illegible] Mesabi rocks is [illegible] the subject, when you [illegible] go into these [illegible] the most important [illegible] minerals that were [illegible]

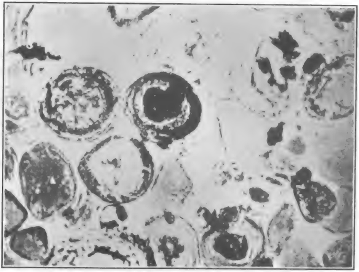


Fig. 23—Structure of the Iron Ore Grains of the Mesabi Ore.

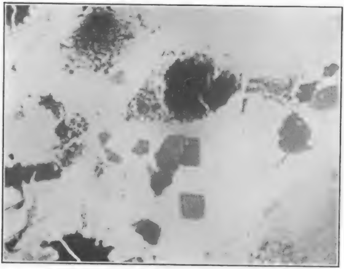


Fig. 24—Distribution of Calcite Crystals in Thin Section.

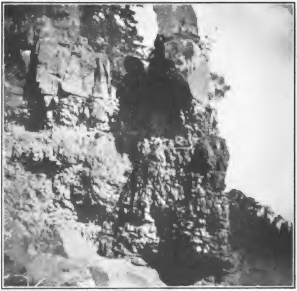


Fig. 22. Rock Bluff of the Keweenawan.

(22) This view, although taken from the igneous rocks of the Keweenawan on the shore of lake Superior, also illustrates the structures seen in the mines and other excavations of the mining region of the Mesabi, and especially at the Mahoning mine. The central part of this figure, showing the crumbling igneous rock, is like the crumbling walls of the Mahoning mine.

Other obvious igneous structures that have been described in the Mesabi mines are amygdaloid, bomb-like balls supposed to have been volcanic bombs, sheeting and jointing characteristic of lava, and "purgatories," such as are seen along the Lake Superior shore.

12. Microscopic Characters.

The most interesting, and at the same time the most indisputable evidence of the igneous nature of the original Mesabi rocks is microscopic. It is getting pretty close to the subject, when you examine it microscopically, and it is not possible to go into these characters, except to speak briefly of one of the most important features. I mentioned that one of the new minerals that were formed by the alteration of the volcanic sand is

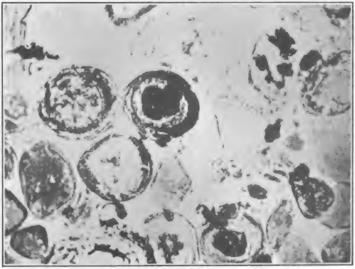


Fig. 23—Structure of the Iron Ore Grains of the Mesabi Ore.

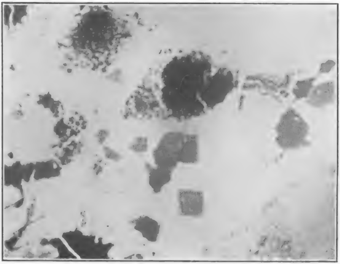


Fig. 24—Distribution of Calcite Crystals in Thin Section.

13. Greensand or Greenalite.

When this green substance was first discovered it was thought to be the source of the iron ore, and was called glauconite, but when it was found to differ from glauconite a new name was given to it, viz: greenalite, although still believed to be the source of the iron ore. This green substance is not abundant, but in reality is quite insignificant in amount. The actual relation of this substance to the iron ore can be seen only when examined microscopically. It would be too long a story, and unadapted to this audience, to detail the method of this examination. Suffice it to say that this green substance has nothing to do with the origination of the ore It is itself a secondary product, coordinate and parallel in its history with the iron ore itself, and with the limestone and the quartz. Its intimate relations with the iron ore and quartz, showing its independent course of development from some other source, can be traced out beautifully in microscopic thin section.

(23) I call your attention to this view. It shows the aspect of the Mesabi iron ore grains, as they appear in thin section under the microscope. The most of this slide is secondary quartz. The round grains composed of several shells one within another are partly made up of ore and quartz, and partly of the green substance mentioned. These substances are independent of each other. They do not blend, and rarely mix. They are like separate layers of separate minerals in a geode. No one of them can be said to be the source of the others, but it is evident that they had a common source outside and entirely separate from the geode itself.

Chemically it has been found that all the elements of the Mesabi rocks, both iron ore and quartz, as well as the green sand, and the limestone and the kaolin, can be derived from the volcanic sand of which those rocks almost wholly consist. It is reasonable to suppose, from all the facts, that a series of active volcanoes existed about where the Mesabi range now is known and that their products fell into a heated ocean, whose waters attacked the debris, dissolving the uncrystalline glass and distributing the results of such solution in favorable places, here forming beds of quartz, here of kaolin, here limestone and here of iron ore.

(24) Another microscopic thin section shows the prevalent manner of disintegration of the volcanic sand. As in the last the most of this slide consists of quartz. It is invisible in the slide, but some disintegrated grains of volcanic glass sand still show their outlines, though composed mainly of iron ore. The chief purpose of this view is to show the crystals of calcite which here are tightly embraced in the quartz, and which must have originated at the same time as the quartz, and doubtless from the same source. Such calcite, when abundant enough, forms the thin beds of limestone which are found near the bottom of the black slate of the Mesabi range.

14. The Cuyuna Range.

But you may by this time impatiently ask: What about the Cuyuna range? That is a very live subject to Aitkin. Is it entirely isolated from both the Vermilion range and the Mesabi range, or is it an extension from one or the other? Is its ore like that of the Vermilion or like the Mesabi ore? It is evident that it is necessary to be able to answer such questions before any intelligent exploration in unknown areas can be carried on. Without a correct understanding of how the ore lies in the formation much money may be wasted in fruitless search in barren rock. If the lay of the ore in the rock is understood a few crucial drill holes would, in numerous cases, be sufficient to settle the question.

If I am not mistaken a casual comparison of the Cuyuna range with the description now given of the other two ranges will be enough to show whether the Cuyuna ore is in rocks of the Archean or in rocks of the overlying Taconic. Let us ask a few questions, **first:**

As to the ore. Is it a soft ore like the Mesabi, or a hard one like that of the Vermilion range? If it is soft, is its softness due to the crushing of an ore which was originally hard, like the Chandler ore? What are its impurities—silica, phosphorus, manganese or sulphur, and is it hydrated, so as to make it limonite? Does the ore graduate in coarseness in one direction so as to become a conglomerate, and in the other so as to be a paint-rock, or red shale? Is the ore granular, and does it grade into a rock such as that called **taconyte** on the Mesabi range?

second—

As to the rocks in which the ore lies

Are the rocks nearly or quite vertical or nearly horizontal? Are they crystalline or fragmental? Are they greenstone, or any of the forms of greenstone schist? Are they associated with mica schist or with granite? Are they black slate? And if of black slate do they consist largely of volcanic debris? Is there a large amount of jasper associated with the ore?

In the light of our present knowledge of the Cuyuna range some of these questions cannot be answered decisively, and some of them are perhaps not sufficiently distinctive. That is, if answered the answers might be equally applicable to the Archean or to the Taconic. Such, for instance, is the question whether the ore is generally hydrated, so as to make it limonite. Indeed an answer to that question, based on what we know at present of the two ranges, might be entirely misleading, for we do not know from anything in Minnesota, whether the ores of the Archean are ever limonitic, but we do know that the Mesabi ore is sometimes limonitic to a marked degree. Hence since the Cuyuna ore is markedly limonitic the answer would show an agreement with the Mesabi, and tend to prove that the Cuyuna ore is of the age of the Mesabi. If we go outside of Minnesota, however, we find that iron ore from the Archean, in the Lake Superior region is sometimes largely limonitic, as in the Michipicoten region where, at the Helen mine, the bulk of the ore shipped is limonite instead of hematite. Hence the fact that the Cuyuna ore is limonitic, might be indicative of either the Mesabi or the Archean

All of the other questions, however, carry with themselves, and in their answers, more or less import touching the main problem i. e. whether the Cuyuna range is of the Archean or the Taconic. The following answers can be given to the foregoing questions:

As to the Ore.

The ore is hard, but less hard than the Vermilion ore. It carries considerable phosphorus, and occasionally much manganese. In general, so far as exploited, it is nonbessemer. Sulphur is present in the gangue, but not notable in the ore itself.

The ore is principally limonite.*

The ore is never conglomeratic but is associated with some paint rock. This paint rock is not known to be a fragmental shale, like the paint rock of the Mesabi, and is comparatively scant.

The ore is not granular, but massive, previous to mining, and the rock taconyte has not as yet been met with.

As to the Associated Rocks.

The position of the formation is nearly or quite vertical. The rocks are metamorphic, and sometimes may be called crystalline.

They are largely of greenstone, or green schist. Both granite and a fine silky mica schist are found on the Cuyuna range, the latter in many drill holes.

In some instances a carbonaceous (graphitic) black slate has been found on the Cuyuna range, but its structural relations are unknown. It may be due to early igneous action, but it has not been found to be referable to volcanic debris, like the slates of the Mesabi range.

The ore is sometimes associated with jasper, but not to a marked extent. It is identical with the jaspilyte of the Vermilion.

These answers are based on what is now known of the Cuyuna range, and are liable to correction as new discoveries are made, but it is not at all likely that such discoveries will change the general purport of present evidence.

It is hardly necessary to state that the testimony of these answers is overwhelmingly in favor of the Archean age, and hence in favor of the Vermilion range. It would be vain, therefore, to search for the Mesabi ore, or any ore like the Mesabi ore, in the Cuyuna range as now developed.

There is still one important proviso that ought to be mentioned in favor of the possible discovery of the Mesabi ore on the Cuyuna range, viz: at some places on the Cuyuna range some of the red shales, and the igneous conglomerates characteristic of the Mesabi ores, have been discovered by diamond drilling. Such red shale was found near the west end of Dam lake, having a thickness of thirty feet, and the igneous conglomerate (or breccia) was found at eight miles east from Brainerd. These indicate the extension of the igneous rocks of the Mesabi over some part of this region, and it would be wise for future explorers to give careful heed to these discoveries, to the end that an extension of the Mesabi ore may be brought to light.

The first discovered of the Iron ranges was Marquette, and at that place for some years ore was mined from rocks of both ages before it was found that both existed in the limits of the range. It seems very likely now, that the Cuyuna, the newest of the iron ranges discovered, may duplicate Marquette in having both represented, and that Aitkin fifty years hence will be as far-famed as Marquette is today.

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* Latterly the ore of the Cuyuna has been found to consist largely of hematite.

BULLETIN OF THE
MINNESOTA ACADEMY OF SCIENCE

[*Vol. 5, No. 3, May 1917*]

Paper read at the 365th Meeting, February 5, 1916
Directors' Room, Public Library Building, Minneapolis, Minn.

THE ANTIQUITY OF MAN IN AMERICA COMPARED WITH EUROPE

The Last Address of the late
NEWTON HORACE WINCHELL

Originally presented before the
Iowa Academy of Sciences, at Cedar Falls, Iowa,
April 24, 1914.

BULLETIN OF THE
MINNESOTA ACADEMY OF SCIENCE
(Vol. V, No. 3, May, 1917.)

PREFATORY NOTE.

The Minnesota Academy of Science invites the attention of the scientific public to this study, "The Antiquity of Man in America Compared with Europe," the last work of the late Professor Newton Horace Winchell. This paper, based on a lifetime's investigation and study of the allied fields of geology and archaeology, represents his latest conclusions on the subject discussed. It was originally presented before the Iowa Academy of Sciences, at Cedar Falls, Iowa, on April 24, 1914, only one week before his life work was brought to a sudden and untimely close. It was again read, before the Minnesota Academy of Science, at its 365th meeting on February 5, 1916, by the author's friend, co-worker and successor, Dr. Warren Upham, Archaeologist of the Minnesota Historical Society.

Dr. G. Frederick Wright, author of "The Ice Age in North America and Its Bearings on the Antiquity of Man," in a letter written to Mrs. N. H. Winchell in June, 1915, says: "Professor Keith, of London, the most eminent comparative anatomist of Great Britain, was in Cleveland a few weeks ago lecturing on the Antiquity of Man. He made repeated references to your husband's work, relying with complete confidence upon his conclusions. Indeed, the investigations of no other American have so much weight with him."

The publication of this highly important paper is of especially timely value, amidst the late new evidence and renewed discussion of this subject, because it was the first public study, since the epoch-making discovery of the ancient human remains at Lansing, Kas., and in Nebraska, to marshal the evidence for the paleolithic antiquity of man in America as well as in Europe. This study is also a fitting culmination to Professor Winchell's 45 years of scientific research and to the "Memorial" number of the Academy's Bulletin (Vol. V, No. 2), published in July, 1914.

T. B. Walker, President.
Frederick J. Wulling, Vice-President.
Harlow Gale, Secretary.
Minnesota Academy of Science.
Minneapolis, May, 1917.

Last Lecture of Prof. N. H. Winchell, at Cedar Falls, Iowa, April 24, 1914, a week before his death; read also from this revised copy (by Warren Upham) at the monthly meeting of the Minnesota Academy of Science, February, 1916.

THE ANTIQUITY OF MAN IN AMERICA COMPARED WITH EUROPE

By Newton Horace Winchell.

I trust that no one will suppose that the age of Man in America can be expressed in years, with any degree of accuracy; nor that in this brief discussion any effort will be made to equate the biblical account of man with the facts of science. These two records may constitute two parallel series, but they were written by different authors, for different purposes and from different starting points.

For a few minutes it is the intention of this lecture to sketch only the scientific facts that bear on the age of Man in America, and more specially to review in a somewhat systematic and logical order some recent discoveries which have an important bearing on this question. Some of these scientific facts are not strictly recent discoveries, but have been known for twenty or more years, and the discovery consists rather in learning their significance when correctly aligned together and read as a whole; but others of these facts are new, and it is largely because of these late discoveries that we have been prompted to put into a systematic rearrangement some of the facts hitherto well known.

European Primitive Man.

As European remains of primitive man are the most remarkable and also the best known, they are to be taken as a standard for comparison with American. Hence it is proper at the outset to glance at the results of the latest discoveries in the eastern continent.

The finding of the Neanderthal skeleton, the Engis skull, the man of Spy, the skeleton of Mentone, followed in late years (1907) by the Mauer jawbone near Heidelberg, the skull of La Chapelle-aux-Saints (1908), the skull of Krapina in Croatia (1899), of Le Moustier in France (1908), Forbes

Quarry, Gibralter (Sollas, 1907), Galley Hill in England (1888-95), and of Piltdown, England (1912), as well as several others in France, Germany, and Italy, has served to put the former existence of a primitive type or types of man in the eastern continent beyond the realm of hypothesis, and to range it among the positive facts of science. These remarkable late discoveries have as yet not been apprehended generally, and a short synopsis of them will be presented here for the purpose of comparison as an introduction by contrast to a consideration of discoveries in America.

EOLITHIC MAN.

There are some specimens whose extreme variation, from the average form of skull and jawbone of the human type, throws doubt on their exact relation to man. These are the Pithecanthropus erectus of Java, the Mauer jaw, found near Heidelberg, commonly called Homo heidelbergensis, and the Eoanthropus dawsoni, found lately near Piltdown in England.

PITHECANTHROPUS ERECTUS.

As to Pithecanthropus, it certainly is, in some respects at least, intermediate between man and the ape, as indicated by the name given to it by Dubois. In other words it is, in his opinion, the veritable "missing link." But authorities differ. While admitting that the fossils found by Dubois are related to both man and the ape, some authorities consider that the animal was essentially an ape, with some human characters, and others that it was a man with some of the characters of

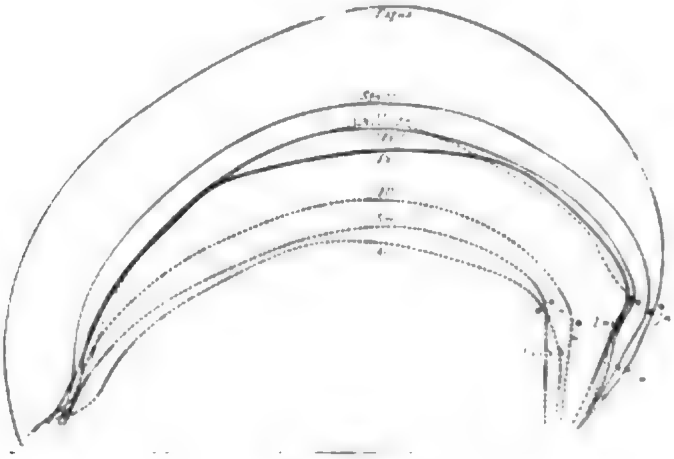

Fig. 1.

the quadrumana. Probably the following summary review and conclusion of Professor Sollas are as near the just result of the long discussion as we shall ever be able to attain.

Fig. 1. Outlines of skulls: Topmost, a New Guinea native; 2d and 3d, Paleolithic man, of Spy; 4th, Pithecanthropus; and the three lower are skulls of monkeys. (From Prehistoric Man, by W. L. H. Duckworth, 1912, page 5, after Dubois.)

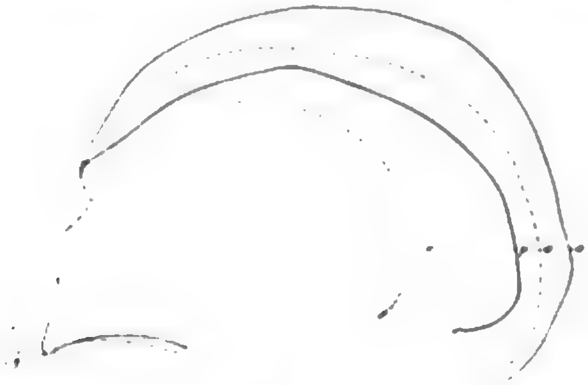

Fig. 2.

Fig. 2. Outlines of skulls: Topmost, a European; 2d, an Australian; 3rd, Pithecanthropus; 4th, lowest, a Chimpanzee. (From Ancient Hunters, by Prof. W. J. Sollas, 1911, page 36.)

1. The form of the skull has a nearer approach to the anthropoid ape than to man.

2. That particular fold in the frontal lobe of the skull which is in the region known as the "Broca area" and which controls the power of speech, is twice as great as in the anthropoid apes, and indicates that Pithecanthropus had acquired the power of articulate speech.

3. The size of the cranial cavity puts Pithecanthropus 110 cubic centimeters higher than midway between the lowest known capacity of human skulls and the highest ape, and in this character, which is the most distinctive, Pithecanthropus is well on the human side.

Pithecanthropus was found in beds which are near the top of the Pliocene or base of the Pleistocene, in a position in which both geologically and anthropologically such an intermediate form might theoretically be expected.

HOMO HEIDELBERGENSIS.

A most remarkable jawbone was discovered near Heidelberg in 1907. This bone was associated in the same stratum with several kinds of extinct species, such as Elephas antiquus, allied to the existing African elephant, rhinoceros etruscus, two species of bear, a lion not distinct from the existing African lion, a dog almost identical with the present wolf of the Pyrenees, a boar, horse, bison, and others. The entire group shows that the age of the jawbone was near the upper part of the Pliocene, or at the bottom of the Pleistocene.

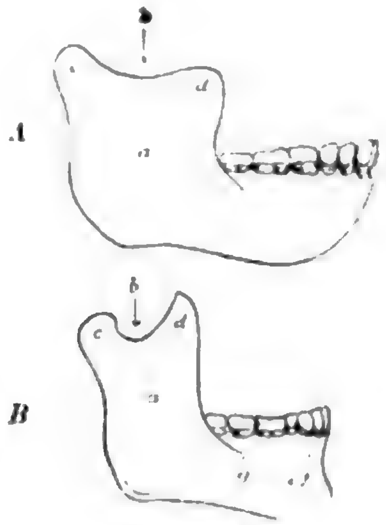

FIG. 3.

Fig. 3. A, outline of the Mauer jawbone; B, an unusually large jaw of an ancient Briton. (From Duckworth, page 11.)

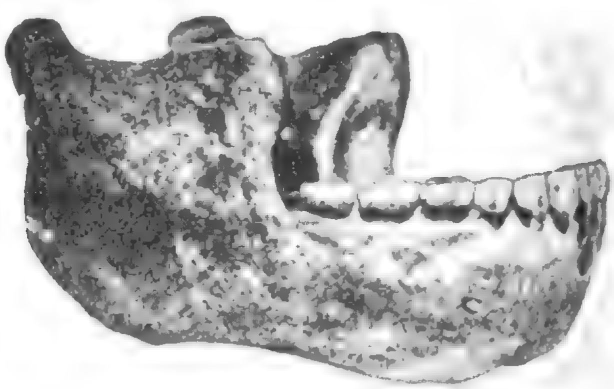

FIG. 4.

Fig. 4. Side view of the Mauer jaw. (From Origin and Antiquity of Man, by Prof. G. Frederick Wright, 1912, page 310.)

As compared with the lowest of present human beings, this jaw is seen to differ in the following particulars:

1. While the teeth are distinctly human, they are small in comparison with the jaw itself.

2. The ascending ramus is of enormous width compared with the same in existing man.

3. The sigmoid notch which characterizes the upper line of this ramus in nearly all human jaws, is a shallow gentle depression, in this approaching the lowest human types.

4. The uppermost rear point of the condyle is higher rather than lower than the coronoid process, the reverse from that shown in an unusually large jaw of an ancient Briton, illustrated by Duckworth, from specimens in the Cambridge museum; but the actual difference of level between these in the Mauer jaw is unusually small.

5. The lower margins of the jawbone, instead of running in a nearly level uniform plane, undulate upward midway from front to rear. There is also another similar undulation on the front margin.

6. The chin is rounded and retreating, instead of angular and projecting.

These contrasts are made evident by the following view which shows (from Sollas) the jawbone of Mauer, of an Australian native, and of a chimpanzee. The Mauer jaw is represented by the heavy continuous line, the Australian by the light continuous line, and the chimpanzee by the dotted line.

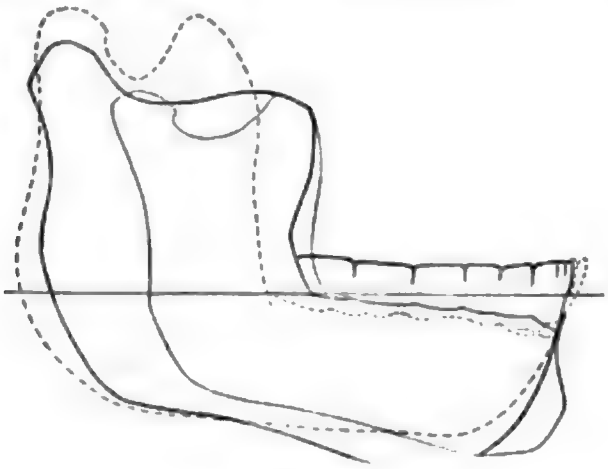

Fig. 5.

Fig. 5. Outlines of the Mauer jaw (thick line), the jaw

of an Australian (thin line), and of a chimpanzee (dotted line). (From Sollas, page 46.)

THE PILTDOWN SKULL.

The remarkable Piltdown skull was found only a few years ago, and a full description was pubilshed in 1913, in the Quarterly Journal of the Geological Society, of London, Vol. LXIX, where the fortunate discoverers (Dawson and Woodward) have given full descriptions and illustrations. In all respects, so far as the specimens can be interpreted, the Piltdown man and the Heidelberg man are nearly allied, almost identical. This similarity extends to the great width and strength of the ascending ramus, the shallowness of the sigmoid notch, and the undulating lower line of the horizontal ramus. Other resemblances might be noted, but it is sufficient to say that the Piltdown skull is placed unhesitatingly in the same group as the Heidelberg jaw, and that, as they appear, from the fossil associates, to have lived at practically the same date, they are representatives of a once wide-spreading type of the primates which hunted the elephant, the boar, the mastodon, the hippopotamus, and the beaver, over an extensive area in central Europe, and spread also westwardly into England. The channel which now separates the British Isles from the continent was not yet formed, and that gives a pre-Glacial date for the type. As these three specimens are so nearly allied, and are found at about the same geological date (upper Pliocene or near the base of the Pleistocene) they can be set aside easily into one group, and in a previsional way can be denominated Pliocene Man, but without any very definite limitation to the significance of the term. From southern Asia to western Europe a similar and almost identical type of early man or man's precursor was spread over the earth.

THE QUESTION OF EOLITHS.

Perhaps the most important part of the late discovery at Piltdown is yet to be mentioned. For several years the question of the true nature and origin of certain flints found in Europe has been discussed by European archeologists. They are called eoliths, and although they show signs of artificial chipping they have not been accepted as of human origin, with any approach of unanimity. As remarked by Professor MacCurdy, the coincidence of these flints with the Piltdown skull at the same geological horizon seems to put a quietus on further doubt, and to reveal to us the status of the most primitive flint-chipping industry.

The very ancient type represented by these earliest of subhuman remains may be called therefore, very reasonably, Eolithic Man, since now they are proven to date from practically the same period of time, and inasmuch as the chipped flints found in the same situation as the Piltdown man had already been called "eolithic."

Paleolithic Man.

The remains of man, or of anthropoid man, which have been reviewed thus far, are to be distinguished from another set of remains, likewise found in Europe, which are recognized by European archeologists as of a higher type. They differ from the foregoing in the form and capacity of the skull, and in the shape of the jawbone and of the femur, and in the teeth. This race is supposed to have made its appearance somewhere in the course of the glacial epochs. The men were small of stature but of stout build. They are represented by the Neanderthal man, and the race has received the same distinctive name.

A large number of individual skeletons have been found. The forehead is low, and, in keeping with the great length of the head, extends far backward. At its front base the frontal torus, or the ridge above the eyes, is very large, and extends continuously over both eyes across the nose. The chin is receding and small, and the notch at the upper end of the ascending ramus of the lower jaw is more marked than in Eolithic man. The molars increase in size from front to rear; with us they diminish, the wisdom tooth sometimes being obsolescent or rudimentary. This produced a distinctly prognathous profile. The legbones, especially the femur, were so curved that it is supposed that the Neanderthal man walked with a stooping posture, being unable to straighten his legs completely at the knees. His feet and hands were disproportionately large. He was anything but a Beau Brummel. Still his industry, as manifested by the implements with which his bones are associated, was considerably in advance of that of the Eolithic race.

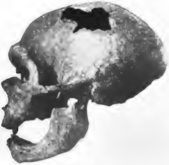

Fig. 6.

Fig. 6. Profile view of the skull from La-Chapelle-aux-Saints. (From Duckworth, page 33.)

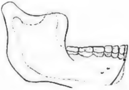

Fig. 7.

Fig. 7. Outlines of the Mauer jaw (continuous line), and the jaw of the Moustier skeleton (dotted line). (From Duckworth, page 41.)

The Paleolithic period, which followed after the period of the Heidelberg or Eolithic man, was probably very long. It was characterized by a fauna which has not yet been separated with definiteness from the period of the Heidelberg man. In some respects the fossil remains of man of this period are similar to those of the Heidelberg man, but the flint implements are distinctly paleolithic and of a higher type than the eoliths. The associated animal remains include Elephas antiquus, the mammoth (Elephas primigenius), Rhinoceros tichorinus, and other species. They seem to be both tropical and arctic, and this character points to important fluctuations of the climate, perhaps to several glacial epochs during the Paleolithic time of Europe, such alternations being well known in America as episodes of the great Glacial period. The succession of physical changes in the Glacial period has not been worked out so satisfactorily in Europe as in America, nor so unanimously accepted; but, on the other hand, the succession of human types has been studied with greater thoroughness and established with greater completeness. The important problem remaining seems to be to find how the two continents may be co-ordinated.

According to Sollas (Ancient Hunters, p. 161), the Australians are the latest representatives of the Neanderthal race, a race which was co-extensive with the land of the eastern continent at a time when the lands of all the northern hemisphere, whether in Europe or in America, stood several hundred feet, and in some places apparently several thousands of feet, higher above the ocean than now, the continents themselves being united.

We next lose sight of man for a long period; and this long interval is filled with indications of momentous change in the earth's surface. The ocean encroaches upon the land, submerging the area of the North sea, the English channel, the Mediterranean, and the land routes to Greenland and to Alaska, separating the continents into distinct land masses.

It is in accordance with all glacial geologists who have investigated the ups and downs of the earth's crust in Europe and America in Pleistocene time to synchronize these momentous changes with the ice-epochs, and to synchronize those of Europe with those of America.

NEOLITHIC MAN.

If we examine the floors of European caves we find remains of Paleolithic man separated from those of Neolithic man by a layer of stalagmite, in which are no bones of any sort. The caves were deserted by man and beast during a long period, and that was in general the time of the Glacial period. Remains of man later than the stalagmite layer are of Neolithic type, and the accompanying bones are of the well known domestic animals, and of the modern reindeer, the common deer, and the European bison; and in every respect the man of Neolithic time grades through the bronze and iron ages into the existing races of Europe and Asia.

SYNOPTICAL VIEW OF THE EUROPEAN SUCCESSION.

1. During the long Pliocene time and in the early Pleistocene, the land stood high. There was no English channel nor North sea, nor the Mediterranean. It was the age of the forerunners of man, Pithecanthropus, Homo heidelbergensis, and Eoanthropus dawsoni, which spread widely, i. e., from England to Java, and possibly to South America as claimed by Ameghino, anthropologist of Argentina. The artifacts are eolithic.

2. In the first glacial epoch, the Gunz epoch of Penck, the continental areas had their greatest elevation and widest expansion. Man and his associates were expelled from Europe or exterminated. There was great accumulation of stalagmite in caves, covering the remains of man and various extinct species.

3. A long period ensued, which embraced remarkable fluctuations both in climate and in fauna. It was the chief age of Paleolithic Man, including the Neanderthal man, the man of Spy, the remains found at Krapina in Croatia, at La-Chapelle-aux-Saints, at Le Moustier, and in numerous other places. This time embraces the Mindel and the Riss glacial epochs of Penck, with the associated interglacial epochs.

4. The Wurmian glaciation of Penck, including the formation of the present (i. e., the latest) valley gravels and the latest tills. Subsidence of the continental areas formed the British channel, the North sea, and the Mediterranean, and submerged northern Siberia, as well as much of the borders of Scandinavia.

5. Retirement of the latest ice-sheet; the Neolithic period, followed by the bronze and iron ages of existing man.

The foregoing condensed sketch overlooks numerous details and differences of opinion, for the purpose of affording a generalized view of those principal events which are agreed on by both archeologists and geologists in Europe. It has been stated by Briart, and is probably true, that the real Quaternary era was made up chiefly of what have been called "inter-glacial epochs," and that the glacial epochs proper were only "brief episodes," interrupting a long period of comparatively mild climate.

COMPARISON WITH AMERICA.

We turn now to America, and what do we find? It is not questioned that in America there has been a similar succession of glacial epochs, separated by interglacial mild epochs. Nor is it questioned that the preceding Pliocene, as well as the Pleistocene interglacial American epochs, had faunas of animal life, and floras of plants, which were identical, or very similar, as to genera, with those of Europe at the same dates, and it is not supposed that these epochs in America were other than contemporary with the analogous epochs in Europe. Further, it is admitted by paleontologists of America that the successive grand changes in the European animals and plants from the Pliocene to the present time have their duplication in American geology. It is only in regard to the presence of man among these animals that American scientists are not in accord.

Let us begin with the Pliocene, which terminated upwardly, according to Cope, with Equus beds, and was followed in eastern North America by the Megalonyx beds. Cope at first declared the two were about co-temporary, but on account of some differences in the fauna he concluded that the Megalonyx beds were probably somewhat later than the Equus beds. The special fauna of the Megalonyx beds he enumerated.

Along with the present familiar species, such as the squirrel, wolf, woodchuck, skunk, horse, tapir, and porcupine, are found the bones of several extinct animals, the Megatherium, Megalonyx, Castoroides, Mastodon, and several others. Cope declared, without qualification, that these are of the later Pliocene, but latterly geologists are inclined to include them in the early Pleistocene. They have their parallels in Europe, and, according to Ameghino and others, also in South America.

Was man a part of this early Pleistocene fauna? As in Europe, the presence in America of human or subhuman remains in the latest Pliocene is not settled conclusively. If we accept the testimony of Whitney, Cope, and Williston, men who have given exact and also extensive investigation to this question in America, we must give an affirmative answer. In that case, if the anatomical details of his skeleton could be ascertained, we may reasonably predict that they would resemble those of Pithecanthropus and of the Heidelberg man, as well as the lately found Eoanthropus of Piltdown, England.

Probable Origin and Migration of Earliest Man.

If the earliest representatives of the human species in Europe were a part of the fauna of the later Pliocene (or earliest Pleistocene), they must have originated in the eastern continent, and they must have participated in the migratory movements which characterized that fauna. It may be recalled that the continental areas were then at much greater elevation and of much wider expansion than now, the altitude increasing toward the north. There was no sea expanse to prevent migration from Siberia to Alaska, nor from Europe to Greenland and thence to North America. It is one of the remarkable discoveries of our great American paleontologists that the large mammals have migrated during Tertiary time over the face of the earth from their various starting points, and that the origin of most of them plainly was in the eastern hemisphere. If man followed the same law, he moved in all directions from Asia. He found not only Australia but also America, and he had time enough to spread over the face of the globe, without setting his foot off dry land.

The late discoveries and conclusions of the Princeton Expeditions to Patagonia show that South America was united by a southern swing of the land area with Australia and Tasmania, separating the Atlantic entirely from the Pacific, and making the Atlantic ocean a veritable tropical "Mediterranean."

Either because of the great elevation of the land areas, or because of the decrease of carbonic acid gas in the atmosphere, consequent on the cessation of violence of volcanic ejection near the close of the Tertiary era, or perhaps because of both, the Glacial period came on, inaugurating great physical changes which were world-wide, at last separating the land, as already stated, into continents, and restricting the animals to definite areas.

As there have been found in America no remains of man which can be compared with Pithecanthropus, we may dismiss further consideration of him and inquire whether anything has been found which may be compared with his successor, Paleolithic or Neanderthal man.

It is probable that we owe to Sir Charles Lyell, the eminent English geologist, the earliest mention of human remains that may be referred to this race. In 1846 he was on an extended visit to America, and he described the occurrence of a pelvic bone of man in a collection found at the base of a ravine near Natchez, in the state of Mississippi. This bone was associated with the bones of Mastodon, Megalonyx, Equus, Bos, and others. They were traced to "a clayey stratum," lying below the loess of the locality, which he considered Tertiary, but which is in the stratigraphic position of a layer of gravel and stratified sand which at Vicksburg he considered to be of the nature of glacial drift, since named Orange sand. He at first rejected the idea that man and the mastodon could have been co-temporary in the Mississippi valley, but that view he modified later when evidence of their contemporaneity had been increased greatly. The geological horizon in which these were found is just below the loess, but it is not established whether it is Pliocene or Pleistocene. In the light of later discoveries, however, it seems to be safe to assume that this bone was of the earliest of human remains found in the valley of the Mississippi and that it was parallel, in all essential respects, with Paleolithic man, or with the Equus beds.

The idea which was accepted at first by Lyell, that this bone had been precipitated into the ravine from some Indian burial at the surface, is ruled out by the following considerations:

1. It had the dark color and the same state of preservation as the bones with which it was associated.

2. The fissure, or ravine, in which it was found was formed by surface erosion since the earthquake of 1811-12, hence within a period of thirty-four years. If Indian burials in that time had been undermined by the little stream, that fact would have been observed, and it is probable that other remains of the Indians would have been found; such a fact would be likely to have had its influence on Dr. Dickeson who obtained and preserved the collection, and who considered it wholly as of the same date and origin.

3. Lyell himself in later discussion made allowance for the idea that the human bone may have been of the same date as those of the Mastodon and the Equus, and deduced 100,000 years for its possible age.

THE LANSING MAN.

Whether this bone belonged to the fauna of the Equus beds, or to a later date, may be left uncertain. There are some other discoveries to which we must give attention. According to Udden, the Megalonyx beds of the Kansas valley are "the last general deposits of the plains" of that region. At Lansing, in northeastern Kansas, were discovered some human bones in 1902, which lay below all the loess and in the geest formed by the decay of the Carboniferous limestone and shales. This discovery and its geologic relation to the loess were fully described by the present writer in the American Geologist (Volumes XXX and XXXI, 1902 and 1903). According to Professor Williston, these bones were in the Equus beds, although at the time of discovery and also later, during the discussion that followed, they were not assigned generally to the age of the Equus beds. If Williston's opinion is correct, it appears that the Equus beds extend from McPherson, Kansas, at least interruptedly under the soil of Kansas to the Missouri river; and this brings up the question as to how far northward from the Gulf of Mexico, and eastward from the latest Tertiary lakes of the interior of the continent, the Pliocene, in the latest phase of its sedimentation, may extend.

There is a terrace along the Kansas river, made up (so far as seen) of red clay, visible eastward as far as to where the region was glaciated by the Kansan glacial epoch, which was formed by the outlet of a lake that covered western Kansas. The writer has suggested that this terrace dates from the time of the Equus beds, when the Kansas river connected the interior lakes of Pliocene time with the Missouri river. It lies in a deep gorge cut in the Carboniferous limestone, and that points to an early date for the gorge of the Missouri river at Lansing and southward. At the same time it rather indicates that the Megalonyx beds, in which Udden found traces of granitic gravel and pebbles, are later than some Glacial epoch, and hence that they belong in the Pleistocene.

The Lansing skull was associated with the lower jaw of an infant, which suggests that the adult skull was that of its mother, a suggestion not discordant with the idea that they may both have belonged to the same race as the Loess Man of Nebraska, of which I shall speak soon. When first found, this skull was declared to be that of a woman, especially by Prof. S. W. Williston, of the University of Chicago. Prof. Ales Hrdlicka, however, in his final discussion, states that it belonged to a man. Had the remains of the so-called "Nebraska man" then been known, it is likely that Dr. Hrdlicka would have seen the propriety of considering this as a female of the same race, and more especially as it is difficult to explain why in this entombment the infant should be associated with its father rather than its mother. None of the anatomical characters given preclude the feminine gender, and some of them seem to indicate it, namely, the small stature, 5.4 feet, the comparative slenderness of the bones of the upper extremities, the comparatively small brain cavity, and perhaps the absence of heavy supraorbital ridges. The last mentioned character would be in keeping with its supposed relation to the Nebraska skulls, which are unquestionably those of males.

THE NEBRASKA MAN.

It was not long after the discovery of the Lansing skeleton that a very important discovery was made (1904) by Robert F. Gilder in the west bluff of the Missouri river near Omaha, Nebraska, about 150 miles north of Lansing. Here, according to Prof. Erwin H. Barbour, state geologist of Nebraska, were at least five human skulls and many bones and fragments of bones entombed and scattered in the loess, but lying below a series of other skulls and bones of a different type, the two series being separated by a continuous layer of burnt clay. The upper series can be referred easily to the modern mound-builder, but the lower series he considers much older, and quite certainly of the age of the deposit in which it lies. This loess lies on coarse drift of the Kansan epoch, in the same manner as the loess at Lansing. The skulls, subjected to careful examination, were found to approach the Neanderthal man in the essential differentiating characters. They attracted the attention of Prof. H. F. Osborn of the American Museum of Natural History, who made the statement that they are of a primitive type somewhat in advance of Neanderthal man, and probably more recent than that race.

An extended discussion of the discovery of these human remains in the loess of Nebraska, with notes of the additional descriptions of Barbour and the criticisms of Hrdlicka and Shimek, was published by Mr. Gilder in Records of the Past (Volume X, 1911).

According to Sollas, the modern Australian is a near relative of the European Neanderthal man, and perhaps his descendant, his ancestors having been expelled from Europe by another race who became known later as Neolothic man.

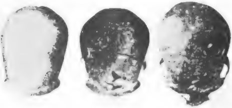

Fig. 8.

Fig. 8. Neanderthal skulls, seen from above. 1, Neanderthal; 2, Spy; 3, La-Chapelle-aux-Saints. (From Sollas, page 156.)

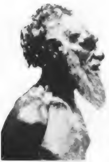

Fig. 9.

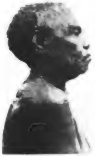

Fig. 10.

Fig. 9. Man of the Arunta tribe, Central Australia. (From Sollas, page 171.)

Fig. 10. Elderly woman of the Kaitish tribe, Central Australia. (From Sollas, page 174.)

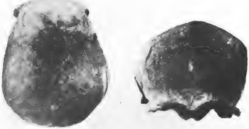

Fig. 11.

Fig. 11. The Nebraska man. (From Prof. E. H. Barbour.)

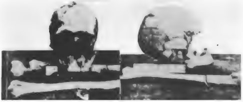

Fig. 12.

Fig. 12. The Lansing woman. (From Mr. M. C. Long.)

The most striking characters of the man of the Neander valley can be expressed summarily:

1. The massive and projecting supraorbital ridges, and the fossa which succeeds to them above.

2. The long low and receding brow. The actual brain cavity was as large as in modern man, whatever may have been the quality of the brain itself.

3. The eye orbits are large, but, sheltered below the massive supraorbital ridges, the eyes were not protruding.

4. The nasal opening is large and particularly broad, and the side bones pass with a somewhat even slope into the malar and temporal bones, indicating that the nose was larger and broader than in man of later types.

5. The average shape of the jaws was prognathous, but some specimens show an orthognathous profile.

6. The lower jaw is large and massive, and the chin is receding or almost wanting, in contrast with the chin of modern man which is projecting or rectangular.

7. The teeth are noticeably different, in that the molars increase in size from front to rear, whereas in present man they diminish from front to rear, the wisdom tooth sometimes not appearing at all. The incisors are small, but the canines are large.

8. The walls of the skull, especially in the frontal parts, are very thick.

So far as comparison can be made, it is apparent that in both the male and the female of the present Australian the skull characters are quite similar to the homologous characters of the Nebraska man, which puts these races about on the same parallel, as to rank, in the scale of human advancement. Hence, if the declaration of the most eminent European anthropologists, to the effect that the Australian is the nearest approach now living to the Neanderthal race, is correct, we are warranted to apply the algebraic formula, "things equal to the same thing are equal to each other," and to conclude that the Nebraska man is the equivalent or the near equal to the Neanderthal man. Corroborative to this syllogism is the fact of discovery, in many places, of the remains of the same fauna that characterized the epoch of the man of the Neander valley, in the loess of the Mississippi valley, including the elephant, rhinoceros, Megaloynx, etc., a well known fauna which I have already enumerated.

Professor Osborn says in his work, "The Age of Mammals": "On Twelve Mile creek, a tributary of the Smoky Hill river in Kansas, in the blue-gray layers directly underneath the recent plains layers, are recorded remains of several species of mammals, one of them Bison occidentalis. The stratum containing the bison was about two feet in thickness and composed of fine silty material of bluish-gray color. The bone bed when cleared off was about ten feet square and contained the skeletons of five or six adult bison. The animals evidently all perished together. In removing the bones of the largest of these skeletons an arrow-head was discovered underneath the right scapula, imbedded in the silty matrix, but touching the bone itself. This evidence," Osborn continues, that "man was contemporaneous with the extinct species of bison, is of the greatest importance. At no great distance from this point bones of the elephant have been found in the same material, namely in the widespread upland marl which covered these skeletons." This account is abstracted from the more detailed description by Prof. S. W. Williston, published in the American Geologist (Nov., 1892). This discovery was made by Mr. T. Overton and Mr. H. T. Martin, assistants of Williston.

Paleolithic Implements of the Nebraska Man.

We discover further evidence of the Paleolithic age of the Nebraska man when we consider the stone implements of the region in which he lived. In the uplands of Kansas, beyond the reach of the loessian floods of the Iowan glacial-epoch, and outside of the moraine of the Kansan glacial epoch, have been found a great many rude stone implements which are like the paleolithic stone implements of Europe. I have treated these at considerable length in a recent publication of the Minnesota Historical Society (Volume XVI, Part I, 1913), "The Paleoliths of Kansas." They are mingled with stone implements of later date and of higher skill of manufacture, the product of a later people, but are distinguishable from them by the scale of weathering and a patination which the later implements do not possess. I cannot take time here to go into details of this investigation, but will state one or two of the general conclusions to which the investigation led, and will show you some views of the implements mentioned, which can be referred with great reasonableness to the agency of the Nebraska man, or perhaps to a race that preceded the Loess man of Nebraska.

1. The Kansas artifacts are of at least three different and successive dates. The earlier, more rude implements were taken as a basis for the making of new implements.

2. Th oldest artifacts were older than the Kansan glacial epoch, and were the only ones that received this descriptive term, Paleoliths.

3. From the Paleolithic stage to the Early Neolithic, or Mesolithic, was a profound break in all the characters, marking a transition to a higher type.

4. This higher type continued through a long period, evidently through several minor fluctuations that produced glacial epochs.

5. The latest or Neolithic culture was an imperceptible outgrowth of the Early Neolithic.

Since the conclusion of this work on the Kansas specimens, partial examinations of stone artifacts from several other states have led to similar conclusions, which, however, have not been published.

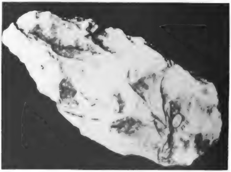

Fig. 13.

Figures 13 to 19 are from "The Paleoliths of Kansas."

Fig. 13. Large paleolith from the Kansas valley. (Plate III.)

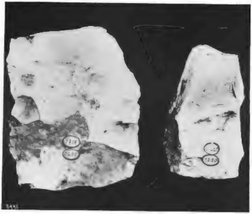

Fig. 14.

Fig. 14. Squarish paleolithic axes or knives. (Plate V.)

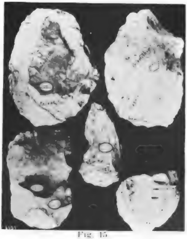

Fig. 15

Fig. 15. Implements showing two paleolithic dates of chipping, the original forms being afterward partly reflaked. (Plate VIII.)

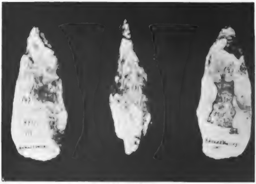

Fig. 16

Fig. 16. Celt showing three dates of chipping by its differently weathered surfaces. (Plate XVIII.) This common and widely distributed implement type has been named a boucher by Sollas, in honor of Boucher de Perthes, the pioneer discoverer of paleoliths in France.

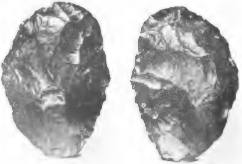

Fig. 17.

Fig. 17. A turtle-shaped paleolith found in Wisconsin. (Plate XV.)

If we take now a general view of the case, we observe at once that in every way in which we make a comparison the Nebraska man is a near repetition of the Paleolithic man of Australia, and of the Neanderthal race of Europe. This is true, for the Nebraska and Neanderthal races, as to the geological epoch in which they existed, the characteristics of their skulls, and the stone implements made and used by them. If we possessed information enough to enable us to compare them more minutely, we are warranted in the belief that they would correspond even more convincingly, however closely we might extend the investigation.

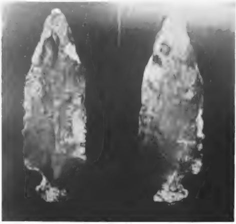

Fig. 18.

Fig. 18. An early neolith of Wisconsin, patinated and decayed. (Plate XVII.)

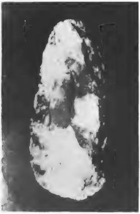

Fig. 19.

Fig. 19. Paleolithic boucher, found in a glacial gravel terrace at Newcomerstown, Ohio. (Plate XVI.)

DIFFICULTIES OF THIS INTERPRETATION.

It may be stated, probably with entire truthfulness, that no great scientific principle was ever established without meeting with obstacles. Sometimes such obstacles become sufficiently numerous and powerful to retard for a time the acceptance of the great principle, but with time and further research the great principle has risen again and again, sometimes from various sources, and perhaps where least expected, and has received such powerful presentation, with such frequent affirmation, that it has prevailed over all opposition, and the obstacles themselves have been turned into supporters instead of opponents.

So with the idea of paleolithic man in America, it has had opposition, and meets with obstacles such that sometimes it seems faint, and almost overwhelmed; but, though almost crushed to the earth, it has survived and risen again each time.

The opponents of this idea can be divided into two classes:

1. Those who are passive and hesitate because they are not convinced, or because they have high respect for those who are outspoken and active, as leaders in opposition, never having taken the trouble to make independent investigation. Sometimes such passive opponents attempt some little research, and I am sorry to say that it has happened that sometimes they have not been able to interpret the facts with any show of independence when such facts have leaned away from the dicta of their leaders, and in some cases they have smothered the correct interpretation under a flood of hesitation and doubt and of adverse suggestions.

2. Another class of objectors are such as have pronounced honestly in favor of some wrong idea, and who have now some individual hobbies to ride and cannot brook any objection. They are like Darius Green and his flying machine. They are ready to risk everything else for their hobbies.

The first class of obstacles are not of much importance, except only that they swell the numbers of the opposition and give it more momentum. Of the second class there are two branches, namely, along the lines of anthropology and along the lines of geology.

Now I wish to consider briefly each of these lines, and at the outset I credit to all objectors the honesty of their convictions. Like Darius Green, they are so positive that they are ready to risk their lives in their defence.

OBJECTIONS ALONG THE LINE OF ANTHROPOLOGY.

The uncertainty of conclusions based on anthropological (i. e., cranial) characters is illustrated by the history of the discussions which have sprung up in Europe concerning the status in human rank of several lately discovered skulls. This uncertainty remains until a sufficiently large number of skulls have been found and accurately measured and described, so that a type of cranial form has been evolved from the mass, and, when so evolved, has been found to be continually consistent with its geological environments wherever found. It is scarcely necessary to state that even in Europe this has not been worked out completely. What we have, in the form of definite results in Europe, is meager and like the confused glimmering streaks of cloudy dawn which precede the full daylight, and is subject to future variation and correction. What I have given you embraces the only fixed conclusions. Among these conclusions is the establishment of the Heidelberg or Eolithic type of man, and of the Mousterian type, the latter alone, or at least predominantly, called Paleolithic man, otherwise known also as the Neanderthal man. I have given you his characteristics, and have compared him with the Nebraska Loess man, showing how nearly they are identical.

Now in the face of this general likeness between the two, it is objected by Professor Hrdlicka that quite a number of skulls of the same type as that of the Nebraska man have been found in the United States, and that some of them are from the mounds of the mound-builder. He also affirms that these characters are found sometimes in the existing Indian. In other words, he concludes that the somatological characters found in the man of the Neander valley, depended on as characteristic of European paleolithic man, are not reliable when found in America, and must be set aside, because it has been found that several skulls of the same or similar type are in the National Museum, supposed, on the best evidence available, to be of modern date. That seems to bring Dr. Hrdlicka up against the current doctrine of European anthropologists. I would be excusable, probably, in leaving him and the European anthropologists to settle this difference in their own way, without any attempt to interfere. But I cannot refrain from adding a few words, which may serve to loosen the tight tangle in which they seem to be tied up.

1. In the early days many specimens were gathered rather loosely, labeled without sufficient exactness as to locality and surroundings, or not labeled at all till after some years, and were given to the representatives of the Smithsonian Institution for this national collection. It would be well to ascertain how many of the list given by Dr. Hrdlicka have indisputably correct records; for it is quite possible that some of them were derived from the loess, like those of Nebraska, which Hrdlicka insists on referring to the "Gilder mound."

2. I will call attention to the fact that the mound-builders were of two dynasties. I have distinguished them as the "Ohio" and the "Minnesota" dynasties. I have supposed that they were both post-Wisconsin as to geological date, but I have seen reason, I may say several reasons, to suspect that one of these dynasties was much older than the other, and even pre-Wisconsin in date; that is, that it preceded the closing part of the Ice age.

3. I would suggest an inquiry whether these supposedly Paleolithic skulls, found in America, may not be actually of the age of Paleolithic man. They prevail, so far as stated, in the non-glaciated parts of the United States. Skulls of Paleolithic date have been discovered in Europe in a tolerable state of preservation. There is therefore nothing unreasonable to expect them in America, had they ever existed in America. The wide area from which this type of skull is now reported points clearly to a people that were spread widely over the country. Is it not more easy for the average intelligence of American anthropologists to allow the verity of what that fact indicates than to confront the colossal task of disputing

with European anthropologists the correctness of their Paleolithic cranial type?

4. Would not the acceptance of a Paleolithic type cranium for America be in harmony with the existence here of many paleolithic stone implements, both being of pre-Wisconsin date?

OBJECTIONS ALONG THE LINE OF GEOLOGY.

Let us now consider briefly the geological difficulties. The "eolian hypothesis" is the hobby horse that carries all these objections, but this horse runs to the same goal as that already mentioned, and flaunts the same banner. The most daring rider is the professor of botany in the University of Iowa, Professor B. Shimek. I know of no geologist of America who mounts this horse and drives so recklessly.

I cannot here take the time to go into the details of this question. I can say only, in general, that there are two fundamental geological facts which are ignored, and apparently unknown, by the adherents of the eolian hypothesis of the origin of the loess, which, it seems to me, would convince a competent geologist of the aqueous origin of the loess of the Missouri valley. First, the loess is stratified as only water can do, from top to bottom; and second, the loess is a feature of the valleys, and not of the country at large. Neither of these features can be accounted for by the eolian hypothesis. If we look in detail at the objections that Professor Shimek has brought against Professor Barbour's interpretation of the facts connected with the locality of the "Nebraska man," we shall see vividly the untenableness of his criticisms.

The differences circle about the question, Is the material in which the bones of the Nebraska man were found "undisturbed loess," as claimed by Barbour, or is it that which would be produced by the excavation and refilling incident to a recent burial?

The descriptive facts stated by the two observers do not differ essentially, with the exception that Shimek makes no mention of a burnt and connected layer separating the moundbuilder remains from those found in the loess-like material containing the skulls lying below that layer. The differences therefore are mainly matters of interpretation and opinion, and the first thing to be noted, at this point, is the unbiased and judicial attitude of Barbour who had never committed himself, so far as I know, on the question of the age of man in America, nor on the origin and age of the loess.

The first objection brought forward by Shimek consists of the admitted association of human bones, drift pebbles (of granite), flint chips, fresh water and land shells; and he affirms that "no such combination of materials is known in clearly undisturbed loess in this country, and none has been found, excepting in connection with mounds, which are clearly the comparatively recent work of man."

That is a sweeping statement, and the reader hardly knows how to accept it in the light of the numerous records that have been published of the finding of these articles in the loess. It amounts to the arraignment of the veracity, as well as the competency, of a large number of observers from Lyell in 1846 down to the latest publications, including the date of the Nebraska man himself. The association of these articles, two or more of them, with the undisturbed loess in the valley of the Mississippi has been affirmed so frequently that it is necessary to assume either that Professor Shimek does not understand the term in the same sense as most geologists, or that he is unable to apprehend the facts so frequently asserted. He simply denies them. The effort to repeat them and to convince him of error would be a task almost impossible to achieve. I will say, only, that all those articles were found by the Concannon farmers in the excavation of the tunnel near Lansing in 1902 when the scattered remains of the Lansing skeletons were taken from the undisturbed loess, in a tunnel 70 feet long.

Shimek next objects that a darker layer is found in what Barbour considers undisturbed loess, at the depth of 7½ to 8½ feet from the surface, and he considers this as "additional convincing evidence of the correctness of his conclusions." We have to admit that it is equally convincing. In order to show its force distinctly, I herewith reproduce Professor Shimek's own photograph, and for the purpose of comparison it is put alongside of one by Mr. Gilder, published in Records of the

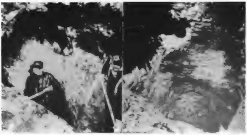

Fig. 20.

Past. The purpose of Mr. Gilder's picture is to show the contrast between the material of the burial mound on the top of the hill and the underlying loess. The dark portion shows a section of the true mound. The lighter portion, behind the man lower down, is the loess in which the primitive bones were found. The purpose of Shimek's picture is to show the dark layer which is outlined by the six markers. He states that the lowest marker (the seventh) is on the only true loess exposed in the pit, all the rest, including the dark layer, having been penetrated by the presumed burial excavation, at a depth of 12 feet below the present surface, by Indians.

But the picture reveals several other features. It shows distinctly the fundamental and universal stratification of the loess. This stratification can be produced in the loess sheet only by sedimentation from water. A tumblerful of unfiltered Missouri river water will deposit in the tumbler a stratified sediment of identically the same structure and composition. As shown in Shimek's photograph, it pervades not only that part which he considers true loess but also that which he calls disturbed loess, and even appears in the dark stratum which he considers to have been an old soil. This common feature links the three parts into a common history, whatever that may have been. Into that history came a force which gave a darker color to a thin stratum. Shimek would assume that here was an ancient soil, and he makes the statement that in it he found a flint chip and a few shells of Succinea ovalis, as if these required a different set of conditions. On the other hand it may be asserted, from the occurrence of these quite widely in the loess, that their occurrence here is convincing evidence, along with the common stratification, that the supposed soil is only a part of the common loess accidentally given a darker color, either by being more moist or by the distribution in the sedimentation of some coloring matter. In the Carboniferous formation along that portion of the Missouri bluffs is a considerable dark shale, so black and carbonaceous that it has led locally to search for coal. To me the most likely explanation of a dark sheet parallel with the stratification of the loess at this place is the erosive action of the river, or wash from its banks by some tributary stream, at the proper time, upon this mass of Carboniferous shale. If it were an old soil, it would show roots of old vegetation, and if they were to be seen Professor Shimek would certainly have mentioned them. But, admitting that this dark layer is actually an old soil, it seems as reasonable to suppose that, in the valley of the great river, it might be buried by water as by wind.

Thirdly, Professor Shimek produces "additional convincing evidence" from a comparison of the loess lying below the "soil" layer with that above it. This lower loess is somewhat discolored toward the top, "close-grained, easily cut through, compact, yellow, with bluish-gray lines and streaks, especially in its lower part, fossiliferous, with occasional iron tubules, and showing the characteristic laminated structure when broken vertically. Unlike the upper, disturbed, layer, it contains few but larger and round nodules of calcium carbonate. The shells are all terrestial and chiefly Succinea ovalis." Barbour reported the finding of scattered fragments of bone in this lowest loess, but Shimek found none. It is not difficult to see that the points of difference between this and the upper stratum are nothing more than could be seen anywhere in the great loess sheet, and amount to nothing as evidence indicating differences in origin or in structure or in date.

It is, however, noteworthy that Professor Shimek took notice of the horizontally laminated structure, and calls it "characteristic" of the loess. It is necessary to say only that there are other deposits which geologists find characteristically stratified and laminated, namely, all the sedimentary rocks of the earth's crust, amounting to several miles when they are placed one on the other: limestones, sandstones, shale, coal, and their variations; also drift sands and clays, particularly the clays from which brick and pottery are manufactured.

If this structure is "characteristic" of eolian deposits, it is necessary to dispense with the agency of the ocean and of lakes, and of alluvial deposition by river, and to let the winds loose from the four corners of the earth, and to call upon them to illustrate how they produced all this lamination. If the idea that lamination is "characteristic" of eolian deposits be accepted, the cornerstone of geology, as set forth by Hutton and followed to the present day, is knocked out, and there is no further use for present-day geologists. The science must be consigned to the limbo of myth and nonsense; and in the fall of geology will fall the collateral sciences which are based on geology.

In short, the eolian hypothesis is radically anarchistic, revolutionary, and destructive. It is apparent that no geologist can accept it without having his eyes blinded by ignorance or by prejudice. Two thorough and competent researches into the nature and origin of the loess have been conducted by geologists of the United States Geological Survey, and they both terminated in the rejection of the eolian hypothesis and in the establishment of its aqueous deposition. Before this conclusion is overturned, it will be necessary that a competent geologist shall go thoroughly into a new investigation and shall conclude by the affirmation of the eolian hypothesis.

Now, in conclusion, having shown you that the two lines of objection to the Nebraska man are based either on partial knowledge or on mistaken opinions, we are at perfect liberty to affirm that every method of comparison that is open to us leads us to accept the evidence of Paleolithic man in America.

END.